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ITALY'S FIRST TURBINE-DRIVEN CRUISER, THE SAN MARCO.

BY DAGNINO ATTILIO.

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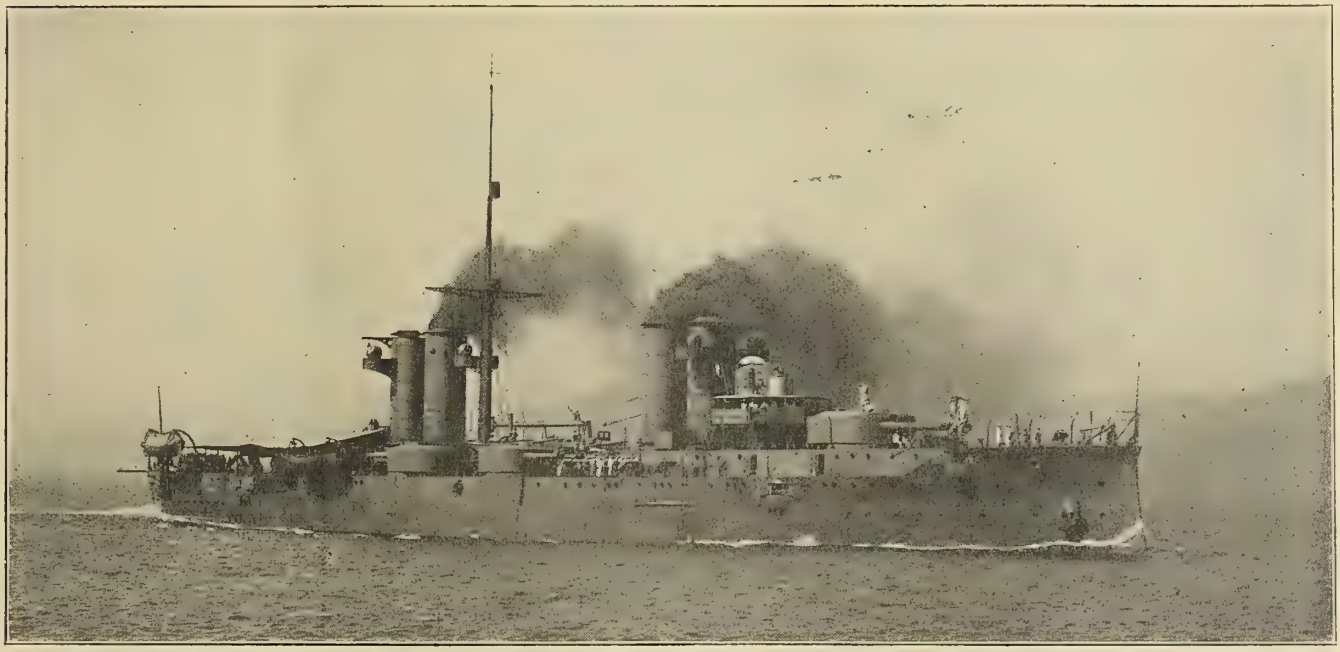
The first Italian turbine cruiser, the *San Marco,* has recently completed a series of very successful steaming trials at Spezia. She was launched at Castellamare, Italy, and engined by Messrs. Ansaldo, Armstrong & Company, of Sampierdarena. She has the following dimensions:

Length over all	461 feet.
Length between perpendiculars	427 feet.
Extreme beam	69 feet.
Depth	39.9 feet.
Mean draft	23.6 feet.

The machinery installation of the *San Marco* consists of steam turbines with the usual auxiliary machinery, electric lighting machinery, steam heating and evaporating plants, deck machinery and appurtenances for handling and maneuvering.

The turbines are of the Parsons type, designed for a steam pressure at the turbines of 210 pounds (gage), and will make about 435 revolutions per minute, developing 20,000 shaft-horsepower. There are four shafts, each fitted with one propeller. The installation comprises six ahead turbines, the high



TURBINE-DRIVEN CRUISER SAN MARCO.

Maximum draft	24.4 feet.
Metacentric height	3.94 feet.
Normal displacement	10,110 tons.

Her armor consists of a belt, with a maximum thickness amidships of 7.87 inches, decreased to 3.16 inches at the ends, and running from stem to stern with a width of 7 feet 3 inches, of which 4 feet 11 inches is below the waterline. The protective deck has a thickness of 1½ inches. The battery is an extremely powerful one, including four 10-inch guns, 45 calibers long, mounted in pairs in turrets, forward and aft, with an arc of fire of 260 degrees. There are eight 7.5-inch guns, 45 calibers long, in pairs in four turrets at the corners of the superstructure. They have an arc of fire of 160 degrees. The secondary battery includes sixteen 3-inch guns, eight 3-pounders and four Maxims. There are three 18-inch torpedo tubes, all submerged.

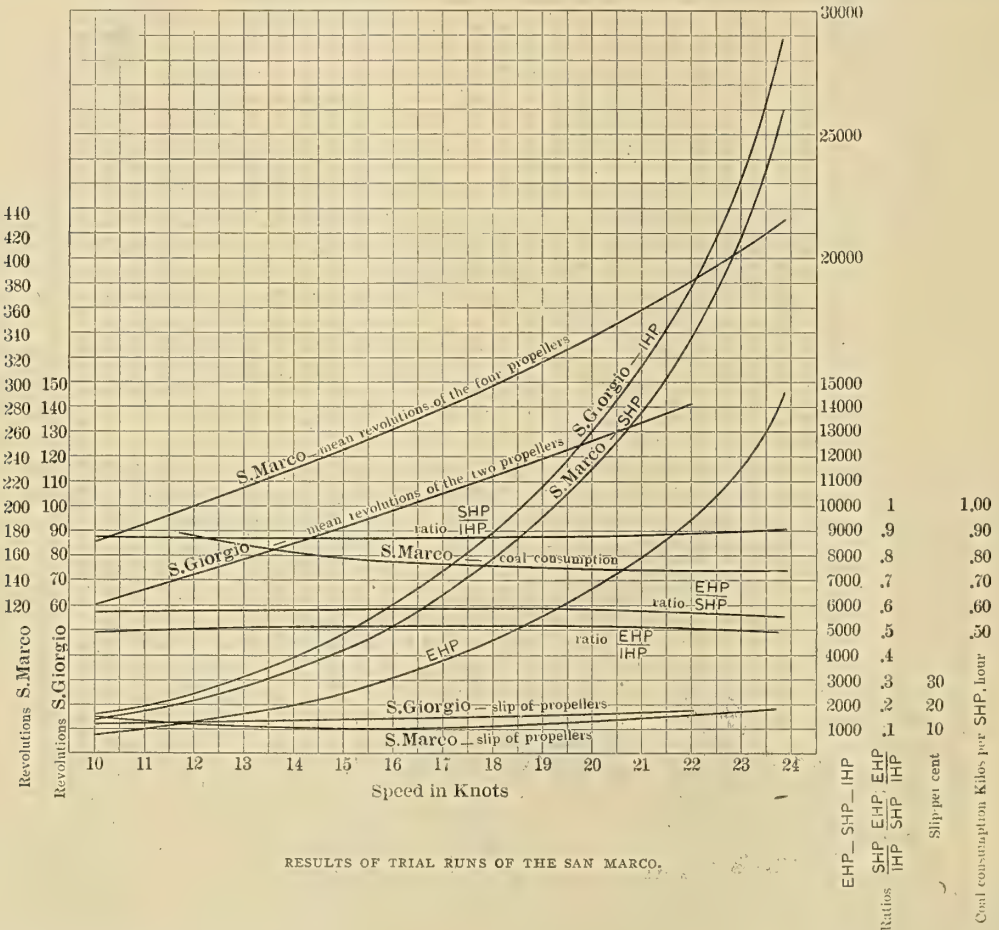
and intermediates are used with low-pressure for cruising in order to secure economy, and four backing turbines, two of which are high-pressure turbines coupled one with each of main high-pressure ahead turbines, and two low-pressure turbines are incorporated into the exhaust ends of each of the low-pressure turbines. The outboard shafts are operated entirely by main high-pressure turbines, the starboard inboard by the low-pressure (starboard) turbine and the intermediate-pressure cruising turbine, and the port inboard by the low-pressure (port) turbine and the high-pressure cruising. In maneuvering the propellers work always in pairs at the same side. All four shafts turn outboard.

The turbine casings are parted horizontally. The lower half carries the box-shaped fore and aft bearings, thrust and adjusting block.

The following data of the turbines are interesting:

	Number of Expansions.	Mean Diameter.	Length Including Glands.
		Inches.	
Main H. P. port and starboard	6	49	15 feet 6 inches
L. P. port and starboard	6	87	11 " 11⅜ "
H. P. cruising	3	48⅝	11 " 7⅜ "
I. P. cruising	3	55	12 " 3⅜ "
H. P. astern port and starboard	3	49	7 " 1½ "
L. P. astern port and starboard	3	64⅞	11 " 11⅜ "

Number of tubes, 8,944.
Diameter, outside, ⅝ inch.
Thickness, 3/64 inch.
Length of tubes between the plates, 7 feet 10¾ inches.
Cooling surface, 11,840 square feet.
Exhaust inlet (rectangular), 48½ inches by 80⅝ inches.
There is one auxiliary and one dynamo condenser, located



RESULTS OF TRIAL RUNS OF THE SAN MARCO.

DATA OF BLADES OF THE TURBINES.

	Rows.	Heights.
		Inches.
Main H. P.—First	13	1
Second	13	1⅜
Third	13	2
Fourth	13	2¼
Fifth	13	4
Sixth	13	5½
Main L. P.—First	5	3 5/16
Second	5	4½
Third	5	6½
Fourth	4	7 5/16
Fifth	4	7 5/16
Sixth	4	7 5/16
H. P. cruising—First	22	⅝
Second	22	13/16
Third	22	1
I. P. cruising—First	20	1 3/16
Second	20	1½
Third	20	2
H. P. astern—First	9	1
Second	9	1½
Third	9	2¼
L. P. astern—First	5	3
Second	5	4⅜
Third	5	4⅜

The main condensers are located one in each engine room at the after end of the low-pressure turbines. They are oval and of the surface condenser type. The principal data of each main condenser are:

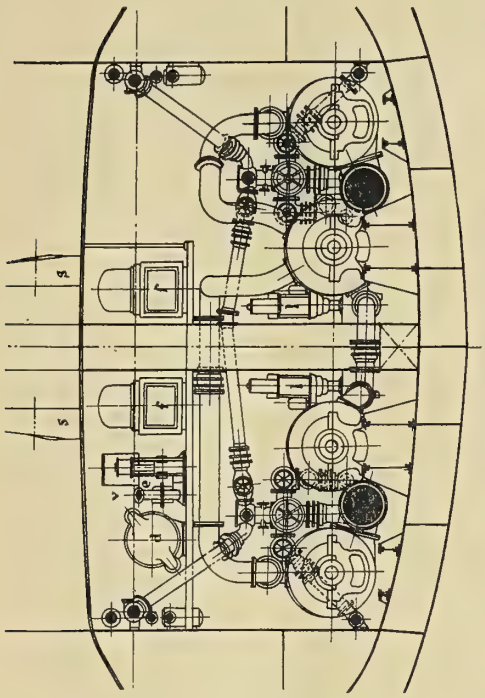
in the forward port engine and dynamo room, respectively. The dimensions of both are:

Number of tubes, 1,550.
Cooling surface, 1,076 square feet.
Length between tube plates, 50⅜ inches.

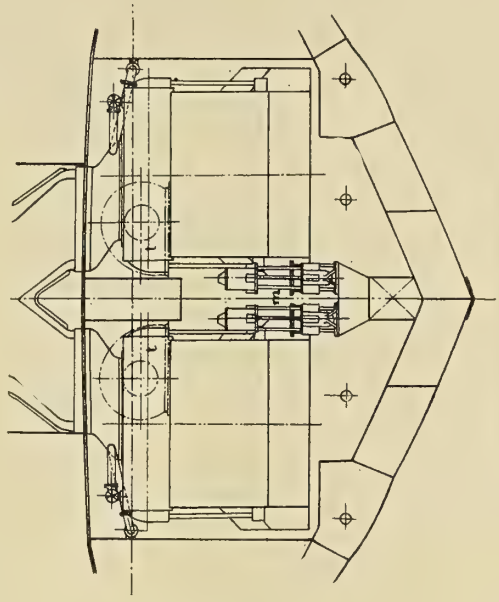
The boiler equipment consists of fourteen units in four fire-rooms. The total grate surface of all the boilers is 1,409 square feet, and the heating surface 48,201 square feet, the ratio is 34.4 to 1. The working pressure is 250 pounds. Forced draft system with closed fire-room is used, one blower being provided for each boiler, driven by a vertical inclosed self-lubricating steam engine.

The official mooring trial, the preliminary progressive trials, the six-hour forced draft full power trials, as well as the twenty-four-hour natural draft trials, were successfully made, and finally a ten-hour contractor's steaming radius trial was completed.

Experiments were made in using the turbines in three ways. First, for comparatively low speed with all six ahead turbines in operation; this combination resulted in a smaller quantity of steam being required than with either of the other two combinations. Steam was then admitted initially into the high-pressure cruising turbine, exhausting into the intermediate-pressure cruising turbine, and from the latter through

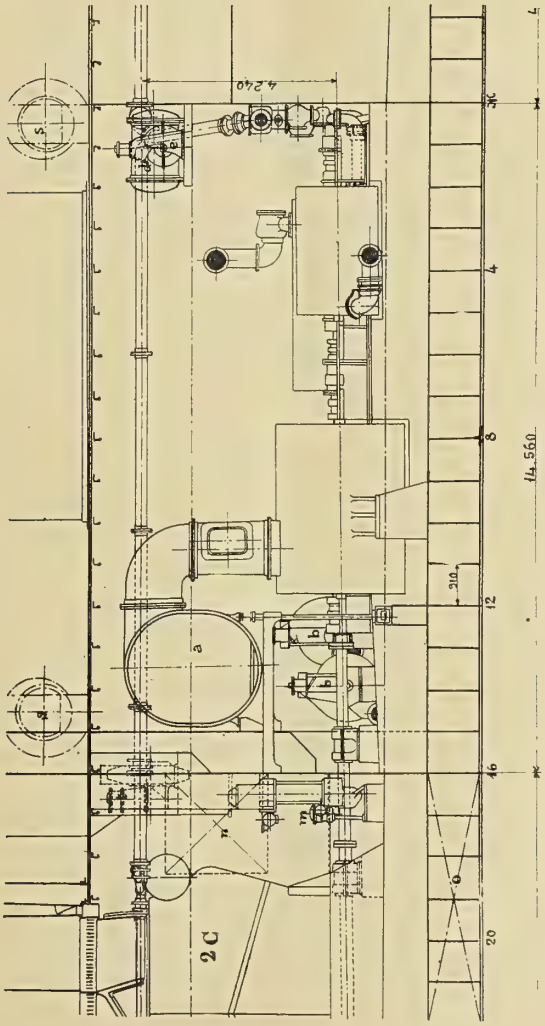


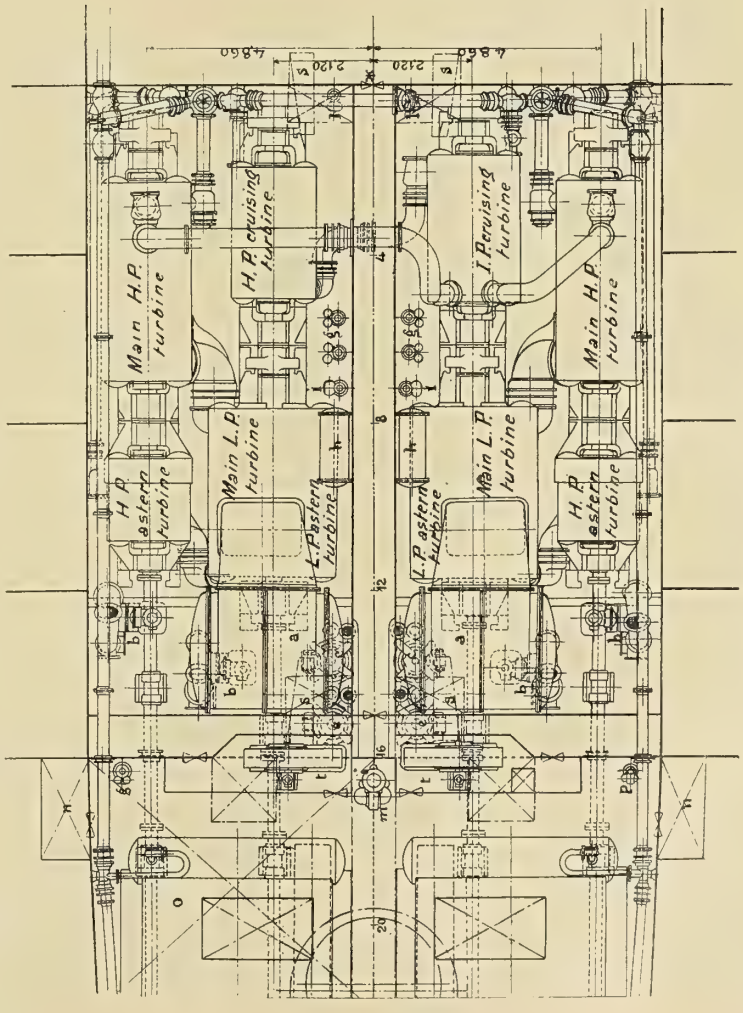
SECTION THROUGH ENGINE ROOM.



SECTION THROUGH BOILER ROOM.

a—Main condensers.
b—Main circulating pumps.
c—Main air pumps.
d—Auxiliary condenser.
e—Aux. circulating and air pumps
f—Evaporators.
g—Oil pumps.
h—Oil coolers.
i—Oil cooler pumps.
l—Fire and bilge pumps.
m—Feed pumps.
n—Main feed tanks.
o—Reserve feed tanks.
p—Drain pumps.
s—Engine room aerating fans.
t—Forced-draft fans.
u—Ash hoists.
v—Aux. feed-water filter.





INBOARD PROFILE AND PLAN OF ENGINE ROOM.

separate pipes to each of the main high-pressure turbines. From these latter steam was exhausted into the low-pressure turbines and finally into the condensers. Second, for speed above 20 knots the five-turbine combination can be used. Steam is admitted initially to the intermediate-pressure cruising turbine, passing thence to the two main high-pressure turbines, and from each of them to the low-pressure turbine. The high-pressure cruising turbine revolves idly in a vacuum. Third, for highest speed only the four main turbines were used, steam being admitted initially to each main high-pressure turbine, exhausted into the low-pressure and then into the condenser, both cruising turbines revolving idly in a vacuum.

In any of these arrangements the power is governed by throttling, though in the six-turbine combination a by-pass valve is fitted, between the first and second expansion, which may be used, within limits, for this purpose. All maneuvering is done with the four main turbines. All the turbines are drained to the air pump. Glands are bolted to the forward and after casing of each turbine. In order to prevent leakage a steam pressure of about 1 pound above the atmosphere is usually maintained in the gland when cruising by means of a system of piping.

A Cockburn's flexible throttle valve is fitted in the main steam pipes, with an emergency governor gear.

The propellers are cast solid of manganese bronze. Their dimensions are:

Diameter, 7 feet 6½ inches.
Pitch, 6 feet 10⅝ inches.
Number of blades, 3.
Total area of blades, 27 square feet.
Shafting, outside diameter, 9⅜ inches.
Shafting, inside diameter, 4⅝ inches.

TEST.

Duration of the Test in Hours.	Number of Boilers in Use.	Average Pressure in Fire-room in Inches of Water.	Pressure of Boilers Steam.	Pressure in H. P. Cruising Turbine.	Pressure in I. P. Cruising Turbine.
10*	4	Nil	245	105	42
18	14	Nil	230	Nil	Nil
6	14	⅛	245	Nil	Nil

Duration of the Test in Hours.	Pressure in Main H. P. Turbines.	Pressure in the L. P. Turbines.	Displacement of the Ship.	Draft Before Test in Feet.	Draft After the Test in Feet.
10*	17	12 inches of vacuum.	10,050	....	....
18	140	2.5	10,050	24.2	23.5
6	200	10	10,175	24.2	23.95

Duration of the Test in Hours.	Average Number of Revolutions.	S. H. P.	Apparent Slip.	Vacuum in the Condensers.	Average Speed
			%	Inches.	Knots.
10*	196.2	2,350	13.3	28	12
18	374	15,700	....	27	21.64
6	427.6	23,030	19.5	27	23.75

* Steaming radius.
Wetted surface 1,420 square feet.

The coal consumption per shaft-horsepower during the steaming radius test was 1.96 pounds, and with natural draft it was 1.60 pounds. During the steaming radius test the exhaust of the auxiliary led into the main high-pressure turbines.

The total weight of machinery installation, including propelling machinery and appendages, auxiliary machinery, piping, boilers and fittings, smoke pipes and up-takes, lagging and covering, floorings, ladders and grating, fittings and gears, stores, tools and spare parts, carried on board is 1,284 tons, and with the water in the boilers, 1,320 tons.

The trial requirements of the *San Marco* were based on the results of her sister ship *San Giorgio,* fitted with reciprocating engines, but the *San Marco,* when going at full power, was required to give a half knot more than the *San Giorgio;* this condition was easily surpassed.

A MODEL TEST ON A STEAMER.

BY G. G. HOLBROOK, S. B.

The work which is the basis of this article was performed by the author in the summer of 1909 on Lake Minnetonka, Minnesota. The object of the experiments was to determine the relation between the actual power required to drive a vessel and the power as determined by a series of model tests, by means of simple and inexpensive apparatus. The tests were made in open water, using a small gasoline (petrol) launch for towing the model and weighing the pull with an ordinary equal arm scale balance. Although it is not customary to carry on model tests in open water, it was desired to demonstrate that valuable information could be obtained in this way with such apparatus as could readily be obtained in any locality. The concordance of the results from this test compares favorably with model tests made in towing tanks, and seems to justify the procedure adopted.

The boat selected as a basis of this test was a 70-foot wooden steamer owned by the Twin City Rapid Transit Company, of Minneapolis, Minn., and operating on Lake Minnetonka. The steamer was one of a fleet of six boats, exactly alike, constructed by the Rapid Transit Company from designs by R. C. Moore, of Wayzata, Minn. The boats were built to convey passengers from the terminals of the suburban trolley line at Excelsior, a town on the shore of Lake Minnetonka, to different points on the lake. As the boats ran on schedule time to meet the trolley cars, it was desirable that they should be able to operate in all kinds of weather, carry a large number of passengers, and be capable of a fairly good speed. The dimensions of the *White Bear,* the boat used, are as follows:

Length over all	70 feet 3 inches.
Beam, extreme	14 feet.
Draft, extreme	5 feet 5½ inches.
Displacement (light)	35.5 tons.
Weight of machinery	9.2 tons.
Carrying capacity	120 passengers.

The outboard profile and body plan of the boat are shown in Figs. 1 and 2. The boat is wide for her length, to give a large carrying capacity on small draft. The freeboard is rather low, but was sufficient for the protected waters where the boat was used, since the greatest sweep of unbroken water is about 10 miles.

The boat was powered with a three-cylinder, triple-expansion, reciprocating steam engine with the following dimensions: Diameters of cylinders, high, 5½ inches; intermediate, 9 inches; low, 15 inches; stroke, 9 inches. The engine was rated at 150 horsepower at 300 revolutions per minute, but at the maximum power developed in the boat gave an indicated horsepower of 115 at 238 revolutions per minute. The engine exhausted into a jet condenser which maintained a vacuum of 22.5 inches. The boiler was of the Roberts watertube type, with 21.7 square feet of grate surface and 2,300 square feet of heating surface. For maximum power, the boiler pressure was held at 240 pounds by the gage. The propeller was a four-bladed, cast-bronze wheel with a diameter of 43¾ inches

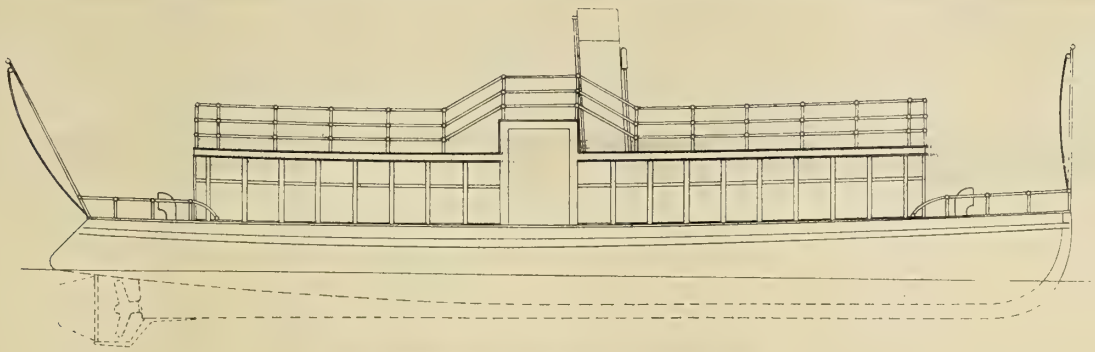


FIG. 1.—OUTBOARD PROFILE OF THE WHITE BEAR.

and a mean pitch of 78 inches. The propeller was not well designed, the pitch varying both axially and radially, and the blades being very thick. This rendered it very difficult to get a fair value for the efficiency of the propeller.

A progressive speed trial was run on the *White Bear* after she had been pulled up on a marine railway, thoroughly scraped, painted and overhauled. In order to get accurate data on the boat, measurements were taken on the hull and propeller while she was hauled out. The lines of the boat were afterwards faired up and the propeller laid down and the efficiency calculated. A course 5,035 feet long was laid off on Lake Minnetonka in 90 feet of water and carefully surveyed. The day of the trial was nearly ideal, with very little wind. Four runs were made at a speed of approximately 6 knots, two runs at 7, two runs at 8, two runs at 8½, two runs at 10, and two runs at the maximum speed of 10.28 knots. Five indicator cards were taken on each run; the times were

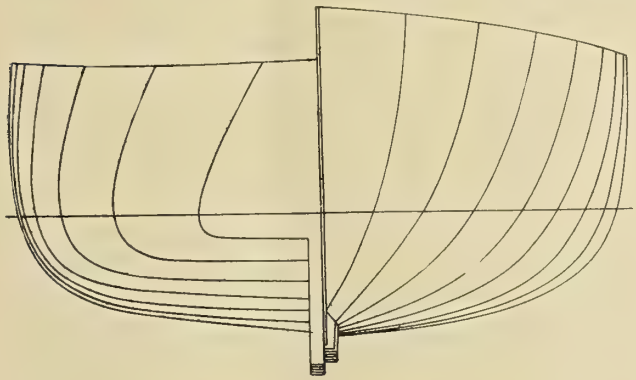


FIG. 2.—BODY PLAN.

read with a stop watch and the boiler pressures and revolutions were recorded. The draft was also taken before and after the test. The results of the speed trials are tabulated in Fig. 3.

The model used in this test was made one-eighth the size of the actual boat, or 8¾ feet long. She was built from the original lines of the ship, which differed from those obtained by measurement by a small amount, easily corrected. The model was built of two thicknesses of thin cedar planking over solid molds, which were fastened to a rigid backbone, giving a very substantial and watertight construction. A short deck was fitted in the bow of the model, to keep the water from splashing in during the test, while the after part was left open to permit ballasting. As soon as the load line was determined by measurements in the actual boat, the same line was located on the model and she was ballasted to float on that waterline. The ballast consisted of bags of sand, weighing in all 80 pounds. The model itself weighed 68.5 pounds, so the total displacement was 148.5 pounds. The center line of the propeller shaft was located on the model as shown in Fig. 4, and the towing cord attached to the bow in that line. This rendered any change of trim occurring in towing the model virtually the same as caused in the actual boat by the thrust of the propeller.

Considerable experimentation was necessary to devise a satisfactory towing arrangement for the model, for on its

Results of Speed Trial						
Speed knots	6.37	7.12	7.85	8.40	9.89	10.28
Revs per min.	131.0	148.9	168.0	183.1	223.5	238.0
Red. M.E.P.	334.9	44.79	55.98	66.69	102.58	119.95
I.H.P.	17.6	26.8	37.8	48.9	91.9	114.8

FIG. 3.

efficiency depended the success of the entire undertaking. A sketch of the towing device is shown in Fig. 5. A 30-foot gasoline (petrol) launch with a 14-horsepower engine was used to provide the motive power. In order to have a steady foundation to support the scales for weighing the pull of the model, they were mounted on a temporary platform set up on the deck of the sailboat which was towed by the launch. The sailboat was a broad, shallow boat of the skimming-dish type, was easily towed and afforded a very stable support for the scale. The sailboat was towed directly astern of the launch and connected to it by a rigid strut, 12 feet long. If the engine of the launch missed an explosion, and so tended to make the speed irregular, the momentum of the sailboat would be transmitted to the launch through the strut, and so would minimize any variation in speed. To give the sailboat greater stability about 2,000 pounds of sand ballast were placed in the

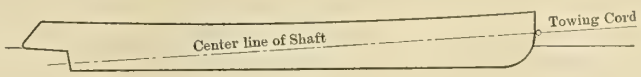


FIG. 4.—POSITION OF TOWING CORD FOR MODEL.

boat, almost doubling her displacement. This additional weight materially assisted in keeping the speed of the launch steady. It was desirable to get points on the resistance curve of the model at as low a speed as possible. The problem arose, therefore, to slow the speed of the launch down to about 1½ miles an hour and yet have the engine turning over fast enough to run steadily. This was accomplished by taking a plank, 8 feet long and 2 feet wide, weighted on one edge, and placing it athwartships under the sailboat directly in front of the bilge boards. The plank exposed a large area to the line of motion of the boat, and so greatly increased her resistance. With this arrangement in place it was found that a speed of one and one-tenth miles an hour could be obtained with the

engine running steadily at between 200 and 300 revolutions per minute.

After considerable investigation as to the best type of weighing apparatus, it was decided to use an ordinary equal arm scale balance. The scale arm was graduated in ounces and quarter ounces up to 1 pound, and additional weights, when needed, were placed in the scale pan. The scale was mounted on a platform on the port side of the mast of the sailboat. The towing cord was conducted over bicycle wheels with the tires removed, as frictionless pulleys, from the model to the scale. One wheel was secured in a horizontal position on the end of a 12-foot boom swung out to the side of the boat. The other wheel was placed vertically under the weighing platform and led the cord up to the scale. The model was towed about 4 feet aft of the outer end of the boom, in which position it could rest in quiet water, usually undisturbed by any waves from the launch. The towing cord consisted of strong fishing line which had enough elasticity to take up sudden shocks and jerks, yet when stretched out taut by a steady pull would transmit all variations of resistance large enough to be detected by the scale.

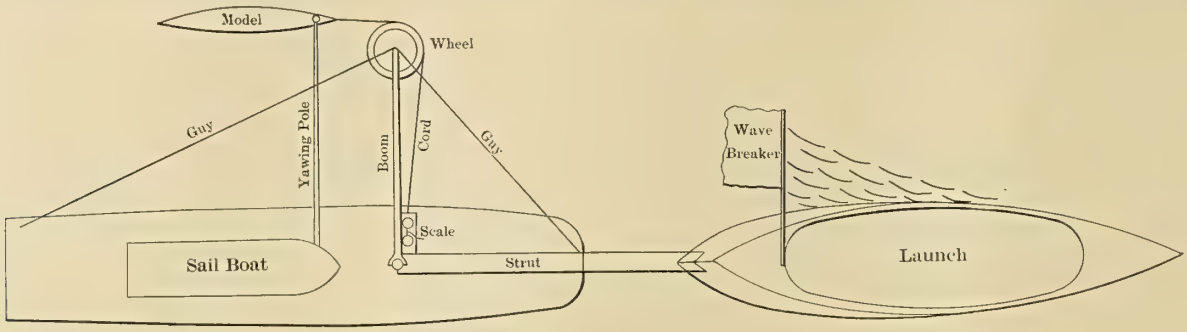


FIG. 5.—EXPERIMENTAL TOWING DEVICE.

In the preliminary runs it was found that the pull varied incessantly, and to such a degree that it was impossible to balance up the scale. The horizontal arm would vibrate so violently as to hit the stops and prevent any possibility of accurate weighing. To surmount this difficulty the device illustrated in Fig. 6 was attached to the scale. Two rubber bands were looped over yokes, as shown. One yoke was fastened to the same ring which held the towing cord, and the other was fastened to the framework which supported the scale. The latter was secured so that the tension in the elastics could be adjusted to any desired amount. A pointer was fastened to the cross-bar of the balance, which moved up and down over a vertical scale. The tension in the elastic was regulated so that with no pull on the towing cord, and the sliding weight set at 8 ounces, the arm of the balance was horizontal. This brought the pointer over the zero mark on the scale. Other divisions were marked on the vertical scale, corresponding to the position of the pointer when the sliding weight was set at different points, 2 ounces apart. With this arrangement it was found that the rubber bands took up small, irregular variations in pull; and by a careful setting of the sliding weight the pointer could be made to vibrate over equal distances on either side of the zero line. When this condition was obtained the weights balanced the average pull.

It was found that the model had a tendency to yaw occasionally from one side to the other when being towed. This yawing brought an increased pull on the scale and vitiated the results. To prevent this a long spike was placed in the bow of the model and a wire loop fastened to the end of a bamboo pole. This loop was then placed over the spike and the other end of the pole held in the sailboat. The distance from the loop to the boat was adjusted so that when the model was towing straight the loop did not touch the spike. If the model started to yaw, however, it would be checked by the spike striking the side of the loop and the model would again resume its true course. It was found that successful runs could only be made in very quiet water; a slight wind and its accompanying waves would spoil the runs, and at some speeds the bow waves of the launch interfered with the model slightly. A piece of heavy canvas was suspended on a horizontal pole and held on the port side of the launch. The position of the pole was adjusted so that the bottom edge of the canvas dragged over the water. This broke up the waves from the launch, so that they produced no effect on the actions of the model.

An important part of the test came in the laying out of a course for the model runs. This was done in a bay of Big

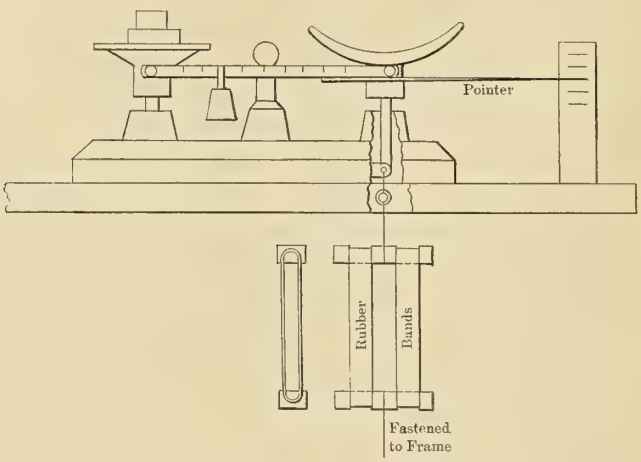


FIG. 6.

RESULTS OF MODEL TEST

SPEED MODEL FT. PER SEC	2.0	3.0	4.0	5.0	6.0	7.0
FRICT. RES.	0-3.7	0-7.8	0-13.1	1-3.7	1-11.5	2-4.5
RESID. RES.	0-2.8	0-4.9	0-8.6	1-0.0	2-1.0	5-0.5
SPEED BOAT KNOTS. PER HR	3.35	5.03	6.71	8.39	10.06	11.74
FRICT. RES.	80-12	160-15	286.0	429-12	599-7	794-3
RESID. RES.	95-6	164-5	286-3	530-0	1091-11	2665-13
EFF H.P.	1.81	5.01	11.77	24.73	52.25	124.7
RATIO $\frac{E.H.P.}{I.H.P.}$	.548	.528	.529	.521	.525	—

FIG. 7.

Island, Lake Minnetonka. The bay was well sheltered from the wind, and had water of sufficient depth for the test close to shore. A course approximately 500 feet long was laid off, with range poles every 100 feet and a free run of 200 feet at each end of the course. One row of range poles was driven into the bottom close to the shore, and another row, parallel to the first, was placed in about 5 feet of water. These poles were driven down so that 4 feet were left projecting out of the water. The course line was located parallel to the line of stakes and about 250 feet out from shore in 10 feet of water. The line of the course was defined by sight poles set up on shore, two at each end of the course, to enable the man steering the launch to get onto the course readily.

It may be well to give a brief description of the manner of running the tests and the positions of the observers. One man steered the launch and tended the engine. He had to use great care to get the launch and the sailboat squarely on the course and running steadily before coming to the first line of range poles. Another person was stationed in the launch to take the time readings in passing the successive marks on the course. A split-second stop watch was used, so the time over

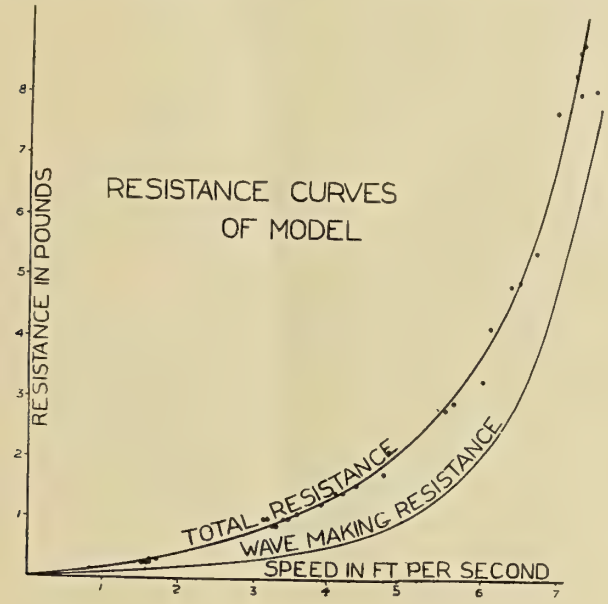


FIG. 8.

the whole course was obtained independently of the summation of the individual readings. Another man recorded the time readings as called off by the timer and the pull as reported by the man in charge of the weighing apparatus. On the sailboat one man took the pull readings and kept the pointer as near the zero mark as possible by shifting the sliding weight. Another man steered the sailboat on the turns at the end of a run and kept her directly astern of the launch during each test. A third man held the pole which kept the model from yawing and disengaged any weeds or floating debris which the model ran afoul of during the run. A tender was towed from the sailboat for use in case it was necessary to make any adjustments to the model during the series of runs.

After the apparatus was all put into working order, sixty runs were made over the course at speeds from 1 to 5 miles an hour. The data from these runs was carefully faired up and unreliable runs discarded. The displacement of the steamer was calculated from the measured lines and found to be 79.635 pounds, or 35.75 tons. The wetted surface of the hull was calculated by Taylor's mean secant method and amounted to 967.75 square feet. The resistance curves of the model were drawn, as shown in the accompanying figure. Average speeds in feet per second were used as abscissæ and the corresponding average pull in pounds as ordinates. Each run was plotted and the best representation curve was drawn. It was necessary to sub-divide this resistance, as experimentally determined, into the frictional and residual or wave-making resistances. The wetted surface of the model was

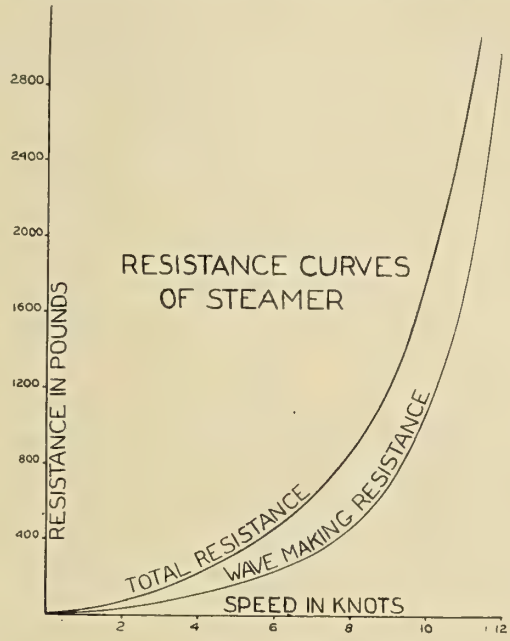


FIG. 9.

calculated from the wetted surface of the boat by the theory of mechanical simultude, and was found to be 14.75 square feet. The frictional resistance of a ship, according to William Froude's formula, is $Rt = F\ S\ V^n$, where Rt is the frictional resistance in pounds, F is the coefficient of friction, S is the

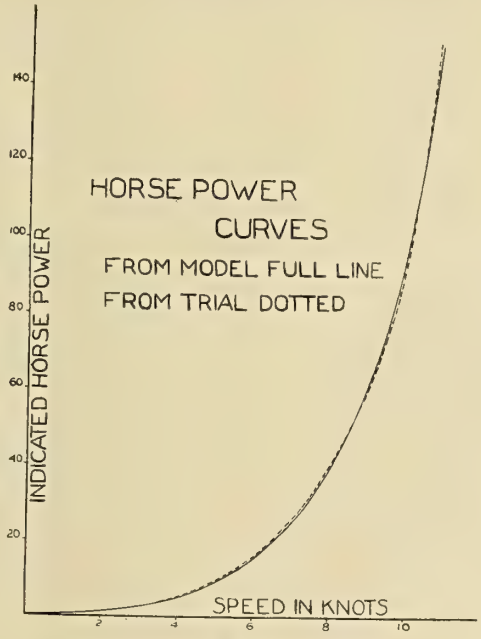


FIG. 10.

wetted surface of the ship in square feet, and V is the velocity of the ship in knots. The value of F for the model was .01153 and the exponent n 1.825, as determined from Froude's tables. By the use of this formula it was possible to compute the resistance of the model due to skin friction at different speeds. A curve through these points gave the curve of

frictional resistance. The residual resistance, the other component of the total resistance, is composed of stream-line resistance, eddy-making and wave-making resistances, and so forth. These resistances cannot be readily separated, so the curve plotted as wave-making resistance has ordinates equal to the difference of the total and frictional resistance ordinates.

The next step was the construction of curves for the steamer similar to those for the model. The frictional resistance was calculated directly from Froude's formula, using the value of F as .0091 and n as 1.825. By the laws of the resistance of ships at corresponding speeds—that is, speeds which vary according to the square root of the length of the ships—the residual resistance is proportional to the displacements of the vessels. Applying this to the steamer and its model, the residual resistance of the boat is to the residual resistance of the model directly as the displacement at speeds which are proportional to $\frac{\sqrt{70.25}}{\sqrt{8.75}}$. This, however, assumes that the displacements of the boat and model are proportional to the cube of their lengths. Using the displacement of the steamer as calculated, and multiplying by the ratio $\frac{(8.75)^3}{(10.25)^3}$, it was found that the displacement of the model should be 153.9 pounds. As tested, the model weighed only 148.5 pounds. This discrepancy is due to the fact that the steamer was built somewhat fuller than the original design called for, and so, at a given load line, would have a proportionally greater displacement than the model. Before the residual resistance of the model could be used in calculating the residual resistance of the boat it had to be raised to the proper value for a model with 153.9 pounds displacement. Using the theory of mechanical similitude, the residual resistance for boats of the same length and at the same speed varies as the two-thirds power of the displacement. Therefore, the corrected resistance of the model equaled the observed residual resistance multiplied by the ratio $\frac{(153.9)^{2/3}}{(148.5)^{2/3}}$. Using this corrected resistance, the residual resistance curve of the steamer was easily determined. The sum of the ordinates of the frictional and wave-making resistance curves at any point gave the ordinate for the curves of total resistance which was next drawn.

Next, the effective horsepower of the engine at different speeds—that is, the power utilized in actually propelling the boat—was determined. The total resistance of the steamer at a given speed, multiplied by that speed in feet per second and divided by 550, gives the value of the effective horsepower at that speed. The effective horsepower curve, whose ordinates are obtained as just described, was affected by a factor to reduce it to indicated horsepower, so that it could be compared with the indicated horsepower curve obtained from the speed trial. Indicated horsepower equals effective horsepower divided by the product of the efficiency of the engine, the efficiency of the propeller and the hull efficiency of the boat. The product of these last three factors is called the efficiency of propulsion. An engine efficiency of 87 percent was adopted as a fair value after comparison with other engines of the same type and power. The efficiency of the propeller was more difficult to estimate, due to the irregularities in pitch and thick blades. The efficiency was calculated from data and curves worked out by D. W. Taylor and allowance made for the bad features of the wheel. The combined efficiency of the propeller and hull ranged from 58½ percent to 63 percent. The indicated horsepower curve was derived from the effective horsepower in the manner just described, and was plotted in the same diagram as the horsepower obtained from the speed trial. These horsepower curves check up very well, and since the curves cross and recross it would indicate that there is no very large constant error entering the work. The variance between the curves is in most cases less than 2 percent. The indicators used in obtaining the indicated horsepower on the speed trial are not accurate to better than 2 percent, so the results check within that allowable deviation.

There is a means of comparison between model work and actual performance which has been found more satisfactory in practice than a direct comparison of indicated horsepower. This consists of finding the ratio of the effective horsepower from the model test to the indicated horsepower from the speed trial. In the accompanying table of results, Fig. 7, the value of this factor is given for the test under discussion. In Fig. 7 also are given the values of the resistances of the steamer and model in pounds and ounces and the effective and indicated horsepower.

The results obtained in this experiment in a great measure vindicate the use of the simple apparatus used in testing. They should also demonstrate the practicability of model testing in open water as a means of estimating the power necessary to drive a ship at a given speed.

STEEL STEAM COLLIER NEWTON.

The steamship *Newton*, which was launched at the yards of the Fore River Shipbuilding Company, Quincy, Mass., Sept. 25, 1911, forms a notable addition to the fleet of the New England Coal & Coke Company, of Boston. She is of the same general type as the *Everett, Malden* and *Melrose*, constructed for the above company about four years ago by the Fore River Shipbuilding Company, and has been especially designed for rapid and economical handling of bulk coal freight between the South and Boston.

The *Newton* is a single-screw steamer with the machinery located aft, constructed of steel with scantlings, in accordance with the American Bureau of Shipping and British Corporation for the highest class awarded by these societies, and the principal dimensions are as follows:

Length from fore side of stem to aft side of rudder post	389 feet.
Beam, molded	54 feet 6 inches
Depth, molded to spar deck	31 feet.
Load draft	23 feet.
Deadweight carried on this draft exclusive of water and bunker coal	7,200 tons.

GENERAL ARRANGEMENT.

The general arrangement of the vessel is such that she has a straight stem, semi-elliptical stern, one continuous complete steel deck, and a full poop, bridge and top-gallant forecastle. Accommodations are provided in the 'midship house for the officers, with saloon, guest room, spare room, pantry, storerooms, baths and toilets; and on the bridge deck is a specially arranged suite for the captain, with a commodious chart room and pilot house over it. The long poop encloses quarters for the firemen, seamen, oilers and petty officers, and in the Liverpool house on the poop deck are arranged the quarters of the engineers, with officers' and engineers' mess, baths and toilets. The crew of the *Newton* comprises forty-three men.

The space allotted to the carrying of cargo has been subdivided by watertight bulkheads into five large holds, constructed on what is known as the self-trimming system. This consists in sloping the hatchways from their side coamings to the side of the ship at an angle of about 45 degrees, the triangular prism formed by this line with the topsides and the

spar deck being cut off and utilized as topside ballast tanks, to be filled with water when the vessel is running light. In addition to these ballast tanks a deep double bottom is provided right fore and aft for the carriage of water ballast besides the usual fore and after peak tanks. The great capacity for water ballast thus provided will insure a good immersion of the vessel when in light condition, thereby providing greater stability and guarding against emersion of the propeller in this condition.

The double bottom is divided longitudinally all fore and aft by a watertight center keelson with the compartments on each side of same handled by independent pumping systems. By filling or draining tanks on either side the vessel may always be kept in upright position while loading. This condition, which is not obtainable in any other colliers on the American coast except the *Everett, Malden* and *Melrose,* eliminates the necessity of trimming cargo while loading, and the holds may be filled to their maximum capacity of 7,200 tons in less than six hours. This vessel, in fact, closely approaches the perfect self-trimmer—the unattainable ideal of all shipowners.

runs by gravity from a daily service tank supplied by the fresh water sanitary pump. The officers' lavatories are supplied with hot as well as cold water.

The electric light plant consists of one 25-kilowatt, direct-connected General Electric Company marine generating set with a combined generating and distributing switchboard. The distribution is on the two-wire system, and supplies current for one 18-inch searchlight, about 150 16-candlepower incandescent lamps and the required running and signal lights.

Living and public rooms throughout the vessel are provided with steam heat designed to maintain a temperature in zero weather of 65 degrees F. Cowl ventilators are fitted to all living quarters.

The life-saving outfit consists of two 24-foot wooden lifeboats, one 16-foot wooden dinghy and one 20-foot wooden gig, fitted with a gasoline (petrol) engine. The lifeboats are stowed on the navigating bridge and handled by ordinary round bar davits. The dinghy and gig are stowed on skid beams outboard of the poop deck house, and handled by davits of the Mallory type.

LARGE STEAM COLLIER NEWTON, BUILT BY THE FORE RIVER SHIPBUILDING CO.

Each hold is operated through two cargo hatches 30 feet in breadth by 15 feet in length. The hatch covers are of steel, and of special construction, to insure absolute watertightness and quick handling of the covers in opening and closing. The vessel is usually unloaded by means of grabs, but a set of kingposts and cargo booms will be supplied for use in emergency or when grabs are not available.

The vessel will be rigged with three pole masts, the fore and main masts being of steel and the mizzen mast of wood. A complete suit of sails will be provided, comprising fore and main sails and staysails.

The poop deck from the front of the house aft and the bridge deck are laid with 3-inch by 5-inch clear long-leaf yellow pine, the holds are ceiled with two 2½-inch thicknesses of North Carolina pine and the flat of the coal bunker with 3-inch North Carolina pine.

The joiner work and furniture in quarters is finished generally in oak. Transoms and seats are upholstered in dark green rep or pantasote. The floors in officers' and engineers' quarters are covered with heavy brown linoleum, in the pilot-house, chart room, captain's office and saloon with rubber tiling; the galley floor is laid in unfinished red tile and the bathrooms in ceramic tile.

The sanitary arrangements are very complete, running water being supplied to all fixtures. The salt water is kept under pressure by a salt water sanitary pump, while the fresh water

PROPELLING MACHINERY.

The propelling machinery, located in the stern of the ship, consists of a vertical inverted, three-cylinder, triple-expansion engine, with cylinders 25, 41, 68 inches diameter, having a stroke of 48 inches, supplied with steam at 190 pounds pressure by three single-ended Scotch boilers working under a heated forced draft system.

The bed-plate of the main engine is of the usual box section type of cast iron in three sections, having six main bearings of cast iron lined with white metal. The bearing caps are of forged steel. All lower halves of main bearings may be removed while the crankshaft is in position. The crankshaft is of the built-up type, of forged steel throughout, in three interchangeable reversible sections. The diameter of the shaft at the bearings is 13¾ inches. The crank pins are 14 inches diameter by 14 inches long, the crank slabs 26 inches wide by 9½ inches thick, and all couplings are 26 inches diameter by 3¼ inches thick, joined by six steel bolts.

The cylinders are supported by six cast iron columns of box section, three front and three back. All crosshead guides are fitted for water circulation. The cylinders are arranged, beginning at the forward end of the engine, high-pressure, intermediate-pressure and low-pressure. The high-pressure cylinder is fitted with a liner, and the valve is of piston type, 13 inches diameter, taking steam in the middle and exhausting over the ends. The intermediate and low-pressure cylinders

are fitted with double-ported slide valves, working on cast iron false seats. All valves are fitted with balance cylinders for taking weight of valves and gear. In addition, the intermediate and low-pressure slide valves are fitted with balance rings on the back for relieving pressure on valve seat.

The pistons are of conical form, the high-pressure is of cast iron, while the intermediate and low-pressure are of cast steel. All pistons are fitted with Mudd's rings and cast iron followers. The piston rods are 6 inches diameter, the low-pressure being fitted with a tail rod 4 inches diameter. Piston rods and valve stems are packed with metallic packing. The forged steel crossheads are secured to the piston rods by steel nuts, the lower ends of the rods being tapered to fit the crossheads. Crosshead slippers are cast iron faced with white metal, and crosshead pins are 7 inches diameter and 7½ inches long. The connecting rods are forged steel, 9 feet between centers. The top and bottom end boxes are cast steel lined with white metal, the caps being secured by forged steel binders. The valve gear is of the usual Stephenson double-bar link gear type.

An 8-inch balanced throttle valve worked by a hand-wheel, and a butterfly valve worked by a hand lever, control the supply of steam to the high-pressure valve chest. The receivers are cast with the cylinders. The main exhaust pipe to the condenser is of copper, 21 inches diameter.

The reversing gear consists of a direct-acting steam cylinder, 12 inches diameter and 18 inches stroke, secured to the back of the intermediate-pressure cylinder. A reverse shaft, 6½ inches diameter, carried in bearings at the back of the engine, transmits motion from the reverse engine to the links. The cut-off of each valve may be adjusted separately by means of a sliding block worked in slotted reverse shaft arms. Smooth action of the reversing engine is secured by a 6-inch diameter piston working in a hydraulic cylinder. A 6-inch by 6-inch single-cylinder reversible turning engine is fitted at after end of the main engine bed-plate on sliding adjustable foundation.

The thrust shaft is 13¾ inches diameter, with nine collars 20 inches diameter, 1⅞ inches thick, forged solid with the shaft. The propeller shaft is 14 13/16 inches diameter, protected throughout its entire length by composition sleeve shrunk in place. The propeller is secured to the tapered end of the shaft by a forged steel nut and feather. All shaft couplings are 26 inches diameter, 3¼ inches thick, connected by six forged steel bolts 3¼ inches diameter.

The thrust bearing is of the usual horseshoe type, having nine adjustable cast iron horseshoes faced with white metal. Each shoe may be adjusted separately, while the entire bearing may be moved fore and aft by means of wedges. The bottom of the pedestal forms an oil chamber into which the collars project. The stern tube bearings are of composition, lined with lignum vitæ.

The propeller is of the built-up type, 16 feet 9 inches diameter, 18 feet pitch, 92.3 square feet developed area, having four adjustable bronze blades secured to a cast iron hub by bronze studs and nuts. The pitch may be adjusted from 17 feet to 19 feet.

BOILERS.

The boilers are 14 feet 2 inches mean diameter and 12 feet 6 inches long, arranged in a single fire room. Each boiler has three Morison furnaces, 44 inches inside diameter, and three combustion chambers. The tubes are 2½ inches outside diameter. The total heating surface for the three boilers is 7,407 square feet, with 165 square feet of grate, giving a ratio of about 45 to 1. The grates are about 5 feet long.

Air for the heated forced draft is delivered to the furnaces by a fan located in the engine room and driven by a 6-inch by 5-inch vertical engine, working at a steam pressure of 125 pounds. The fan is 84 inches diameter, and at 312 revolutions per minute delivers 24,000 cubic feet of air per minute at a pressure of 3 inches of water. On each up-take there is a heater box containing 198 3¼-inch tubes 3 feet 6 inches long, around which the air passes before entering the furnaces.

The vessel is fitted with one double circular stack, 9 feet 6 inches outside diameter, about 80 feet high above the grates.

AUXILIARIES.

The air pump is of the Edwards type, 24 inches diameter, 20-inch stroke, driven by beams and links from the low-pressure crosshead. The body of the pump is cast iron, having a composition liner.

The condenser, placed on brackets at the back of the engine, has a cylindrical steel plate shell with cast iron water chests and covers. There are 1,394 ¾-inch brass tubes, 11 feet long between tube sheets, giving a cooling surface of 3,011 square feet. The tube ends are packed in the usual manner with corset lace packing secured by brass glands screwed into rolled composition tube sheets. Circulating water for the condenser is taken from a centrifugal pump of the Fore River type, having 12-inch suction and discharge. The pump, driven by an 8-inch by 8-inch vertical engine, has the following connections: Suction from sea and discharged overboard through condenser, also a small connection is fitted to the evaporator.

The following additional pumps are fitted: Two feed pumps, 10 inches by 7 inches by 10 inches vertical duplex Blake, Admiralty type, with suctions from sea, after tank, auxiliary condenser, feed tank and boilers, and discharge through the feed-water heater or direct to the boiler through the main or auxiliary feed line, or overboard. The connections are such that either pump can be used independently of the other. When acting as feed pumps they are automatically controlled by a float in the feed tanks.

Two ballast pumps, 10 inches by 12 inches by 10 inches, vertical duplex, with suction from sea, bilge manifold, ballast manifolds, and from engine and fire-room bilges, and discharge to fire main, ballast manifolds and overboard.

Two bilge pumps, 4½ inches by 20 inches, plunger type, connected to the main air pump crosshead, have suction from the engine and fire-room bilges and bilge manifolds, with discharge overboard.

One salt-water deck service and fire pump, 6 inches by 4 inches by 6 inches, horizontal duplex, with suction from sea and discharge to the sanitary system, fire main, deck-washing pipe and engine-water service. This pump is interchangeable with the auxiliary condenser circulating pump.

One fresh-water pump, 3½ inches by 4 inches by 4 inches, horizontal siimplex, with suction from fresh-water tanks and discharge to ship's fresh-water system.

One auxiliary condenser circulating pump, 6 inches by 4 inches by 6 inches, with suction from sea, discharge end of condenser and after tank, through the auxiliary condenser overboard or to the top-side tanks and deck service lines.

One 2-inch Hancock injector is fitted, with suction from the reserve feed tank, auxiliary condenser and sea, discharge to the auxiliary feed line and hose connection.

An auxiliary condenser containing 602 square feet of cooling surface is located in the engine room. Circulating water for this condenser is taken from the deck service and fire pumps.

A feed-water heater of the Quiggins vertical type is located in the engine room on the discharge side of the feed pumps. The heater has a rated capacity of 2,700 horsepower.

One 25-ton evaporator of the Blake type is installed in the after end of the engine room. Steam for operating is taken from the auxiliary steam line, and the vapor is discharged to the condenser, feed tank and after tank.

The refrigerating plant consists of a 1-ton Brunswick am-

monia compressor driven directly by a vertical engine. Both fire-room ventilators are fitted with sheaves for hoisting ashes. A Hyde double-cylinder ash-hoist engine is fitted for raising ashes to the spar deck, where they are handled on trolley ways on each side of the ship. A hand ash-hoist gear is also fitted.

DECK MACHINERY.

The steering gear is of the Hyde steam and hand-gear type, with an 8-inch by 8-inch engine, operated by a telemotor, with steering stands located in pilot house, on flying bridges and on poop deck house aft. An emergency steering gear is fitted, consisting of a tackle leading from a spare tiller to winch on spar deck.

A No. 11 Hyde steam-brake windlass is located on the forecastle deck, operated by a worm and spindle from a 12-inch by 12-inch vertical engine on deck below. The wildcats on the windlass are suitable for 2¼-inch stud-link cable. Large quick operating warping ends are fitted on each side of the windlass. Ten double-cylinder 8-inch by 8-inch Hyde reversible steam winches are located on the spar deck for cargo and hatch-handling purposes. A Hyde steam, quick-warping capstan is fitted on the poop deck with the engine above the deck.

GAS ENGINES; THEIR DESIGN AND APPLICATION.

BY E. N. PERCY.

(*Continued from page* 459.)

EXPLOSIVE MIXTURES.

Many things affect the pressure value of an explosion in a confined space. The principal features are ignition, proportions of mixtures and pressure under which they ignite. By means of many experiments and methods too complicated to detail here, it has been fairly well established that the explosion in an engine is about as follows: First, the mixture is ignited at a given point, and from this point a little ball of flame extends in all directions. The ignition and the forming of this little ball of flame occupy most of the time necessary for ignition, as after the ball has attained a certain size the mixture seems to detonate and to burn so quickly that it is not possible to measure the time. The reason for this is that when the mixture is ignited, especially if there be a fat, hot spark or other certain means of ignition, combustion spreads on all sides, increasing the temperature and pressure until the temperature and pressure of the entire mass has been so raised that it detonates or all takes fire at once from its own heat, irrespective of the combustion traveling out from the original point of ignition. This, of course, refers to modern engines of fairly high compression whose charge is mixed outside of the cylinder and introduced *en masse*. In an old-fashioned engine of very low compression, or injection engines, the process would be very different to that of the engines in most general use, which employ gas or carbureted mixtures.

The pressures obtainable by different mixtures have been worked out in great detail by many experimenters, but most of these experiments have not been under gas-engine conditions, but rather with pure gases with atmospheric pressures undiluted with other gases. However, some practical and valuable experiments have been performed by Clerk and afterwards by Grover. Strong and weak gases show decidedly different characteristics in these experiments. Vapors of gasoline and distillates may be said to show practically the same characteristics as gas, but as there is no accurate way of measuring their volumes the only way of obtaining data relative to vaporous mixtures is to note the effect on the engine or on the experimental cylinder for a definite period of time in the different experiments and then check the amount of liquid used. In pressures and temperature they may be said to bear a general relation to strong gases in proportion to their respective calorific values. It is generally supposed that products of combustion when mixed with fresh charges decrease the maximum pressure and entirely reduce the efficiency of the charge. This supposition is entirely nullified by experiment and by the statement of Grover (page 217, third edition). The experiments carried out by Grover show that the greatest rise in pressure takes place when there are about 30 percent of particles of combustion present under a provided charge. This determines definitely that gas-engine men need not carry scavenging devices to an extreme. While such devices have shown an increase of power it is rather due to the extra mixture admitted to the cylinder than to any increase in efficiency. Making a general review of the experiments the following data may be synopsitized:

Mixtures—When the proportion of gas to air is 1 to 15 the explosion is very weak.

When the proportion of volume is 1 to 16 the mixture can rarely be ignited.

When it is 1 to 4, or 5, the mixture is so rich that it can rarely be ignited.

The maximum point is, of course, purely a matter of chemistry of the fuel, but in a general way it may be said that a mixture of 1 to 10 and 12 is about right.

Relative to inert gases present about 55 percent of the products of combustion may be introduced without preventing the ignition; more than this is apt to so act.

In general, it may be said that the following is true of mixtures of all kinds:

With weak mixtures the maximum pressure is least and the excess of pure air is greatest.

The maximum pressure obtained from a given quantity of gas rises as the excess of air is diminished by the addition of particles of combustion, but this does not hold good when the volume of pure air to gas approaches the proportion of 10 to 1.

The explosion becomes more rapid when excess of air is replaced by neutral gases.

The time limit in the exploding mixtures is an important item in most mixtures of maximum pressure, and is reached in one-eighth to one-quarter seconds; that is, with low compression, with cold cylinders and jump-spark ignition. Under high compression, hot cylinders and hot make-and-break spark, the time would be inconceivably short; at the same time, if the spark is unduly retarded or the mixture unduly rich, combustion will still be in process and the charge goes into the exhaust pipe. These things should be carefully taken into consideration in designing an engine, especially a high-speed engine, as the combustion takes an additional amount of time.

Carbureted mixtures may be taken at the volume of air because they consist primarily of finely divided spray of a nominal volume carried in the air, but when the air becomes heated this spray is vaporized, and occupies a volume approximately equal to that of gas of equal calorific value. No experiments are known which establish this fact, but general action of the engine valves, etc., seem to indicate that such is the case. When an engine, particularly a high-speed engine, persistently blazes in exhaust pipe it is important that the richness of the mixture be reduced or that the speed be reduced or the spark advanced if any economy is to be hoped for.

Temperatures—Maximum temperatures of explosion frequently go as high as 4,000 degrees, but this does not mean that any part of the engine must be made to withstand 4,000 degrees, because the maximum temperature varies almost directly with the maximum pressure and its duration is infinitestimally short. Hence the gas-engine man is not vitally concerned with the maximum temperatures of mixtures, even for purposes of design. If the mixture contains considerable

hydrogen, every provision should be made for cool gas and avoidance of heat.

With very high compression, *i. e.*, 150 pounds upwards, in engines having gases high in the percentage of hydrogen, special provisions must be made for heat and for a large difference in expansion between the cylinder walls and the jacket walls on account of their difference in temperature. The maximum pressure is found to vary almost exactly with the heat units present in the mixture.

The ignition temperature of the various gaseous mixtures is about as follows:

Hydrogen combines with oxygen at about 1,100 degrees F.

Producer gas combines with the oxygen of the air at about 3,700 degrees F. Hence it is easy to see that if a high compression is carried and the engine has good ignition, the combustion will not have to proceed very far before the pressure and temperature are such that the whole mass will detonate.

Pre-ignition should be most carefully guarded against. In small engines there is comparatively small danger of pre-ignition on account of the large amount of cooling surface in proportion to the volume; but as the cooling surface increases as the square of the dimension of the engine wall, while the volume increases as the cube, it is easy to see that a point is reached in which the volume is so much greater in proportion to cooling surface that the center portion of the mixture can become very highly heated from compression and may pre-ignite.

When one remembers that in large gas engines of 24 inches diameter or thereabouts, and with 300 pounds maximum explosion pressure, the total pressure would be about 132,000 pounds, or nearly 70 tons, which would be very apt to wreck the strongest built engine. For this reason it is not advisable to build gas or oil engines of the carbureted type larger than 18 inches in diameter.

In connection with the exploding of mixtures on account of their already mentioned high temperature and small entropy or mass, it is probable that the introduction of water into the cylinder may become a very important factor of gas-engine design in the future, but it will not be done in the present haphazard manner. Among its many advantages are that it raises the thermal efficiency, permits compounding, may dispense with jackets by injection on the suction stroke, and the exhaust may be handled in the same manner as the exhaust of the average steam engine is used to-day for the heating of houses, etc.

Carburetion and Mixtures—The making of proper mixtures for the gas engine with fixed gas is a very simple proposition, simply requiring valves or orifices so arranged that the air and gas flow to the engine in certain fixed proportions in a continual stream. But with liquid fuels considerable complication is involved, because the fuel must first be vaporized and then mixed with air in suitable proportions for combustion and explosion.

The liquid fuels, so far as the gas engine is concerned, divide themselves into two classes—those that vaporize at atmospheric temperatures and those that require higher temperatures. The first class includes gasoline (petrol), naphtha, benzine and lighter distillates; the second class includes the heavy distillates—kerosene (paraffin), alcohol, etc. There are many different carbureters for carbureting the first, and they include the many well-known types used on automobiles and marine and stationary engines.

All of those in common use depend upon the spraying of a jet of fuel drawn into a rapidly-moving current of air, and may be divided into three classes. They are the gravity feed, the float feed and the overflow. In the gravity feed the fuel is led to the jet directly from a source of supply by gravity. The objection to this type of carburetor is that the level of the fuel may be changed and the pressure otherwise changed, causing a difference in the amount of fuel discharged from the jet.

The float-feed type involves the use of a small needle valve, controlled by a float. This and the gravity feed are the most commonly-used types of carburetors because of their greater reliability, and they will submit to a fairly sudden change of conditions, but they are by no means perfect.

In the overflow type of carburetor the pressure at the jet is maintained constant by means of an overflow pipe, which in turn requires a pump to supply the fuel. This type of carburetor is liable to the same variations as the float feed, and has the additional complication of the pump, and the additional advantage of allowing the fuel tank to be below the engine, or, as in the case of a stationary engine, to be buried in the ground, making this type of carburetor almost a necessity for installations in which the tank is required to be buried to meet underwriter specifications, etc.

In addition to these three general types of carburetors are a number of special carburetors which aim to deliver fuel in definite proportions to the amount of air used. Some of them make use of small pump plungers, others fans, driven by the air current. In general, their mechanism has been found faulty as regards wearing qualities or reliability or as regards their inability to deliver definite quantities of fuel in the rapid succession required, yet it is quite possible that such a carburetor will be developed on a practical basis.

In making a carbureted mixture and planning for same it is necessary to carefully distinguish between a mixture in which the particles of fuel are in suspension, seen in fine drops or spray, or in the later stage of the mixture in which it is in the form of vapor well mixed with air. During the first stage it is necessary that the air travel at the very highest velocity or the suspended fuel will condense on the sides of the pipe and run downwards or back to the carburetor, but after the fuel has changed from suspended particles to properly mixed vapor it can travel at a much lower velocity without condensation. In connection with this it should be noted that the velocity of gas in the inlet pipes is as many times greater than the piston velocity as the area of the piston is to the area of the pipe.

The cycles, or number of piston displacements per revolution, have no effect upon the gas velocity, provided there are less than four displacements of mixture per two revolutions, for the reason that when the inlet valve is open and the piston sucking the charge in, the charge must travel in proportion to the full piston velocity, irrespective of the fact that there may be only one piston displacement of mixture in two revolutions. This fact is somewhat modified if the chamber of the valves or the branch pipe have a relatively large volume in which to store mixture between strokes.

If a certain velocity through the carburetor, and for some distance beyond it, is not maintained, and the mixture has its velocity reduced before the suspended particles are all vaporized, these particles will condense and run back into the carburetor, which accounts for the mixture growing weak and firing back when the engine is brought down to low speed, together with the fact that there is less vacuum to draw out the fuel through the nozzle, from which we gather that if it is desirable, as in a marine engine, to have the speed of the engine controllable over a wide range of volume, a very small pipe should be used which will maintain sufficient velocity for carburetion when the engine is running most slowly. It may be said that the proper velocity for the best results is from 5,000 to 7,000 feet per minute; lower velocities than these are apt to deposit fuel on the sides of the pipe, but in the case of a marine engine, running at, say, 250 revolutions per minute, in which a maximum speed of 75 revolutions per minute is frequently desirable if the pipe be designed for the maximum speed, it is easy to see that at maximum the mixture would have an immense velocity.

As a matter of fact, in some well-designed engines this velocity will exceed 25,000 feet per minute, but this limits the horsepower, because the amount of mixture which can be gotten in the cylinder is limited, also through rarefications it reduces the compression, which, in turn, reduces the economy and condemns the arrangement in general. Still, the ability to run a marine engine and hoisting engine and certain other types successfully and reliably at very slow speeds is a most valuable commercial attribute, but when designed with such small pipes, at high speeds it becomes necessary to readjust the fuel valve, because the mixture would become too rich. On the other hand, if the engine be slow with the valve at proper adjustment the mixture will become so rich that the engine will backfire. With large pipes it is almost impossible to run the engine slowly, because the mixture becomes so weak through condensation that the engine misses or fails to explode; with the engine in such a condition, besides being covered with condensed fuel and the curve of the suction channel in the carburetor being filled with a small amount of fuel, it is natural that as soon as the engine is speeded up and the draft increased through these pipes, the mixture is heavily primed with this free fuel and becomes so rich as to fail to ignite and the engine misses fire.

(To be continued.)

The thirty-seventh annual convention of the National Marine Engineers' Beneficial Association will be held in Detroit, beginning Jan. 15, 1912. The headquarters will be at the Hotel Tuller.

THE WESTINGHOUSE MARINE TURBINE REDUCTION GEAR.

Until recently there have been but few attempts to construct gearing for the transmission of large powers at unusually high-tooth speeds. The importance of a system of noiseless gearing to be interposed between a high-speed turbine and the screwshaft of a vessel involving the transmission of many thousands of horsepower, has made the attainment of this object an exceedingly attractive field of investigation.

The most serious problem confronting the designer of such a system of gearing has been the development of a mechanism to insure an elastic, uniformly distributed tooth pressure between gear and pinion to avoid the concentration of an excessive tooth pressure at any single point of the working face, which would result in rapid deterioration and ultimate destruction of the teeth. This problem—which is by no means an easy one—it is claimed, has been effectively and interestingly solved in the Westinghouse marine turbine reduction gear.

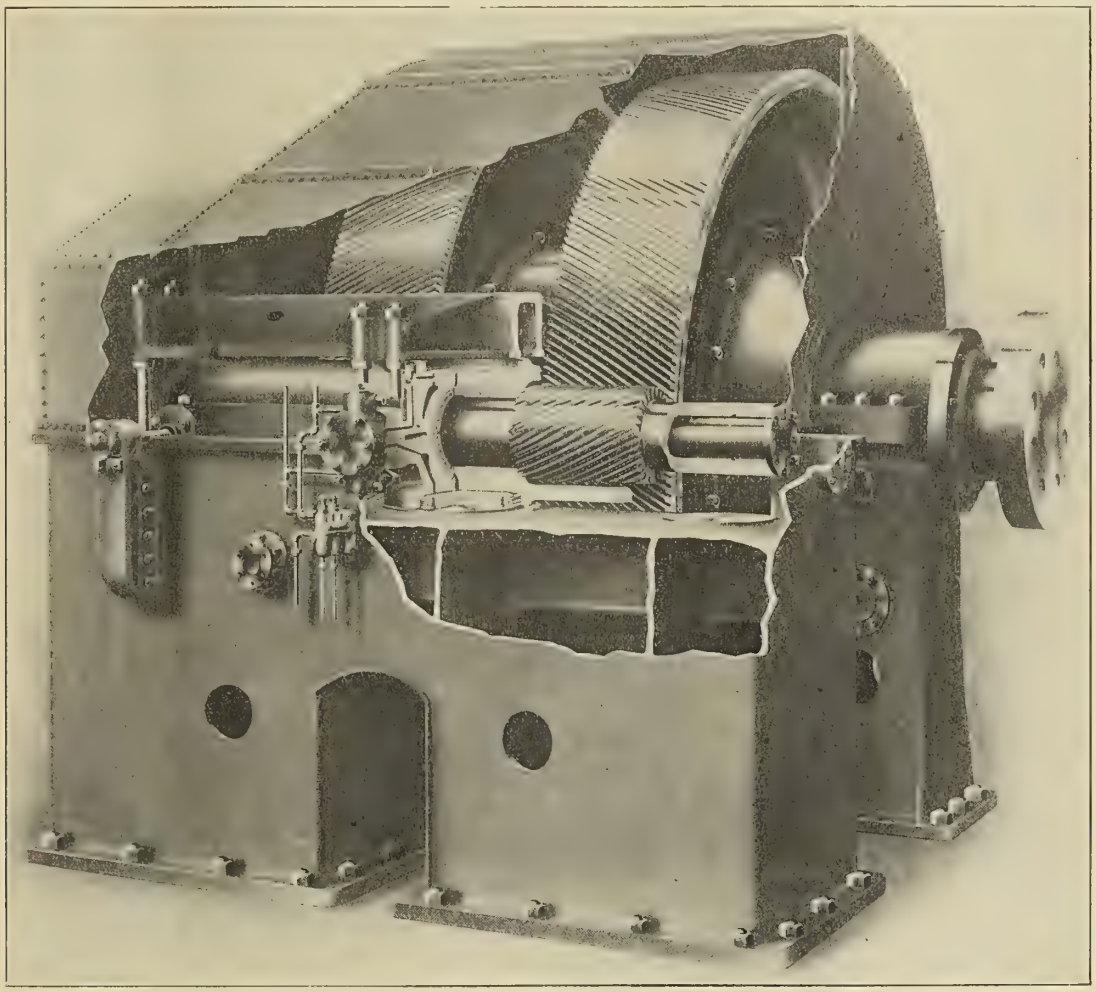


FIG. 1.—PART SECTIONAL VIEW OF WESTINGHOUSE TURBINE REDUCTION GEAR INSTALLED ON THE U. S. COLLIER NEPTUNE.

Fig. 1 is a perspective view—partly in section—of one of the gears installed on the United States ship *Neptune*. Each gear transmits approximately 4,000 horsepower at a speed of 1,250 revolutions per minute for the pinion shaft, and about 130 revolutions per minute for the low-speed or driven shaft. Naturally, double helical gears are used on account of the quiet running qualities of this type, and the fact that the opposing helices automatically balance the end thrust.

The low-speed gear shaft rests in bearings seated in the main casing, and up to this point the design is fairly conventional.

The essential and distinctively novel feature of the design is the hydraulically-supported frame which carries the pinion shaft and its bearings, and by virtue of which the pinion shaft is self-alineing, responding instantly to the smallest unbalancing of the tooth pressure.

This method of suspending the pinion bearing frame, it is

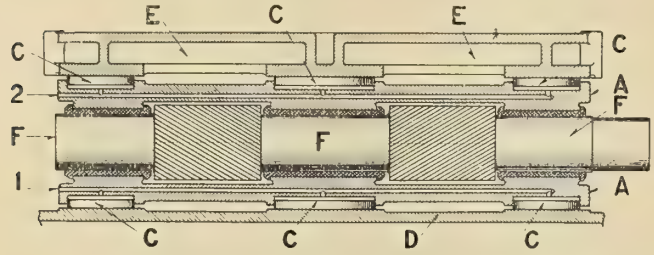


FIG. 2.—DIAGRAM OF HYDRAULICALLY-SUPPORTED FRAME.

claimed, not only insures the perfect balancing of tooth pressures but the fluid cushion interposed between the pinion shaft and the main casing of the gear silences in a large measure the noise usually associated with the operation of high-speed toothed gearing, and prevents all shock or jar from the rapid contacting of the teeth. After a considerable period of operation the gear teeth take on an excellent polish, and show no signs of pitting or other deterioration that usually accompanies hard and continuous service.

The action of this hydraulically-supported frame may be more easily understood by first inspecting Fig. 2, which is a purely diagrammatic section stripped of all mechanical detail that might be confusing, and which illustrates the simple elemental principles of the design. Fully elaborated detail sections are shown in Figs. 3 and 4, and the symbols used in the description refer to the same parts in all of the illustrations.

Referring then to Fig. 2, *A* represents the frame carrying the bearings of the pinion shaft, *D* is a portion of the main casing, and *E* is a rigid strut or beam secured to the main casing by means of a series of steel columns which are shown in Figs. 1 and 3. It will be noted that *A* does not fit closely between the parallel faces of *D* and *E*, but has freedom for a slight upward and downward movement.

On the upper and lower surfaces of *A* are three circular pads bored out to form shallow cylinders in which are fitted short pistons, *C*; 1 indicates a passage or port, which communicates with the three shallow cylinders on the lower side of the frame *A*, and 2 indicates a similar port communicating with the corresponding cylinders on the top side of *A*.

When the gear is working, the reaction on the pinion teeth will tend to force the frame *A* against the casing *D* or the beam *E*, depending on the direction of rotation. If the reaction on the pinion teeth tends to force the frame *A* downwards against *D*, then if oil or other suitable fluid under sufficient pressure be introduced at 1, it will be readily seen that the frame *A* will be lifted clear of the casing, and will actually float on the fluid in the cylinders. Similarly, if the direction of rotation be reversed so that the tendency is to force the frame *A* against the beam *E*, the introduction of fluid under pressure at 2 will prevent the frame *A* from coming in actual metallic contact with *E*. Since all three cylinders of the set that may be in action are connected to the same source of fluid supply, the slightest difference in tooth pressure on either side of the middle point of the pinion shaft *F* will cause the frame *A* to yield at the point where the pressure is unduly high. In thus yielding the excess pressure is relieved, and automatically transferred to the point in the working face of

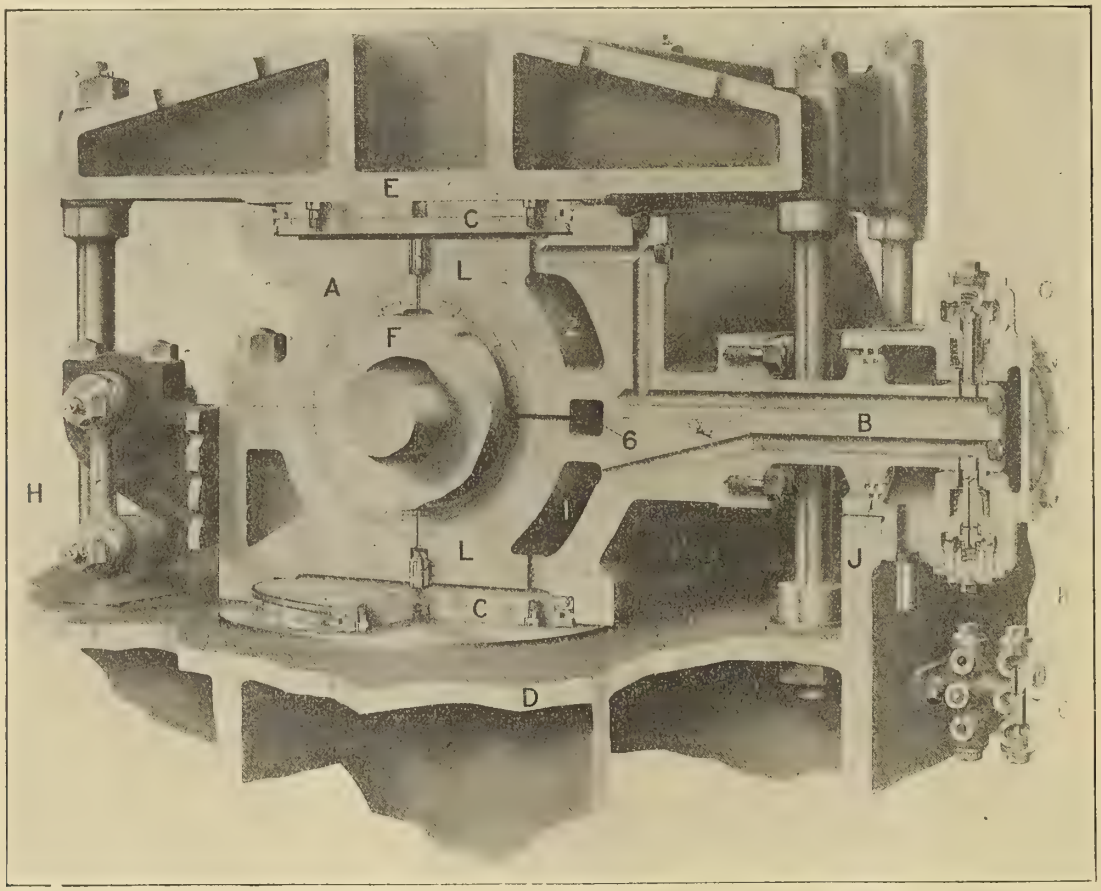


FIG. 3.—DETAILED SECTIONAL VIEW OF THE WESTINGHOUSE REDUCTION GEAR.

the pinion at which the tooth pressure was, at the instant, below normal.

The broad, underlying principle of the design is, therefore, the supporting of the pinion shaft in a frame which literally floats on oil, and which has no metallic or other rigid connection to the main casing. The practical application of this principle involves the accurate and automatic regulation of the fluid pressure in accordance with the load on the gear. The means by which this is accomplished will be understood from a study of the actual detail sections, Figs. 3 and 4.

Fig. 3 is a section through the floating frame at the middle bearing. The frame is split in a horizontal plane for convenience in removing or inserting the shaft and bearings; 1 and 2 are the longitudinal oil passages communicating with the supporting cylinders, and 6 is a duct which conveys lubricating oil at low pressure throughout the length of the pinion frame

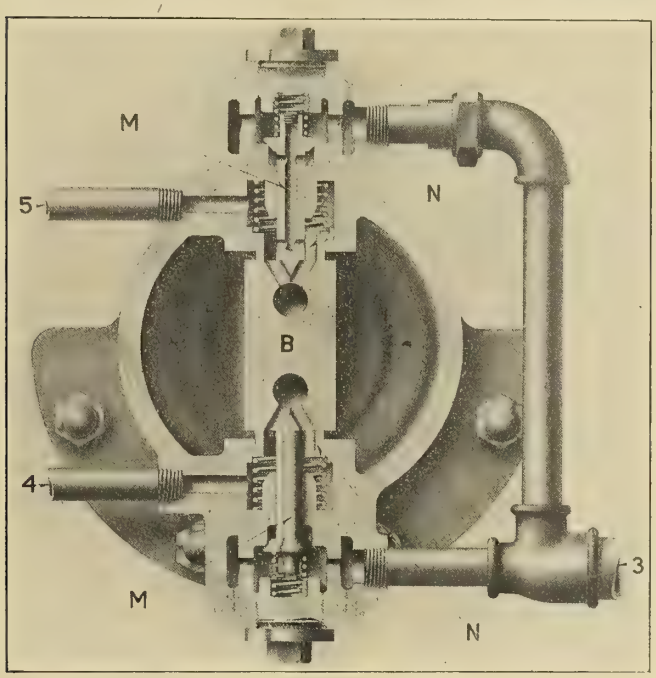


FIG. 4.—SECTION THROUGH VALVE BOX.

and distributes it by means of side outlets to the bearings and to the pinions. *B* is an arm which projects into the valve box *G*, and which contains passages communicating with 1 and 2. *H* is a link which hinges the frame *A* to the casing *D*, so that the slight vertical motion of the frame is multiplied at the end of the arm *B* which controls the oil valves.

For many years it has been known in a general way that if oil be fed to a rotating journal at the point of minimum pressure, it will be carried by the journal to the point of maximum pressure, and if a means of egress is provided the oil may be discharged against a pressure substantially equal to the maximum bearing pressure. Heretofore, practically nothing has been known, however, regarding the quantity of oil that might be pumped through a properly-designed bearing. In the development of this gear it was found that by suitably proportioning the bearings and supporting pistons the former could pump all of the oil required for floating the pinion frame.

Referring to the section through the bearing as shown in Fig. 3, it will be seen that there are small passages connecting the top and bottom of the bearing with the upper and lower cylinders respectively. The bearings draw in oil from the lubricating system, and discharge it through the check valves *L* into the supporting cylinders, and were it not for the automatic regulating mechanism in the valve box *G*, would build up a pressure considerably greater than is required to keep the pinion bearing frame floating in its normal position.

Fig. 4 is a cross section on a larger scale through the valve box *G*. If the direction of rotation of the pinion is such as to bring the lower set of balancing cylinders in action, the excess pressure will tend to raise the arm *B* slightly, and as the ring valve *N* cannot follow it on account of coming up against a shoulder, the surplus oil will escape into the valve box.

Referring back to Fig. 3, *J* is a floating packing, which prevents the overflow oil from spilling directly back into the main casing, and compels it to run off through the drain pipe *K*. This pipe discharges into an open funnel, and the constant overflow of oil is an unfailing indication that the gear is functioning properly. From this funnel the oil may be returned to the main casing to be circulated again through the lubricating system.

When starting, it may be desirable, though not absolutely necessary, to supply the oil to the supporting cylinders from an outside pressure source until the gear attains the normal

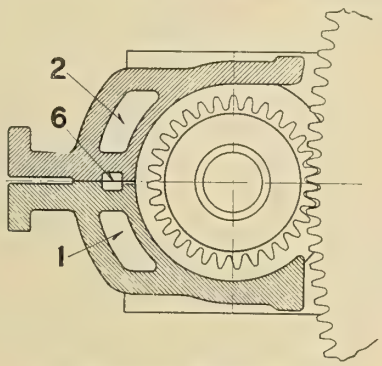


FIG. 5.—SECTION THROUGH PINION.

speed and the pumping action of the bearings is fully established.

In Fig. 4, oil from such an outside source of pressure may be introduced at 3, and led to the upper and lower valves as indicated. If the direction of rotation of the pinion is such as to depress the frame, the arm *B* depresses the ring valve *N* and the conical valve *M*, pushing the latter from its seat. The stem of the valve *M* is hollow, as shown in the section through the upper valve. When the valve *M* is opened the oil passes through the hollow stem, as is clearly shown, into the lower circular port in *B*, and thence to the passage 1 (Fig. 3), which connects with the lower set of cylinders, and is prevented by the check valves *L* from escaping into the bearings. When the balancing pressure has been attained, *B* rises to its neutral position, allowing *M* to seat and prevent further entrance of oil. If, by reason of a reduction of the load, the oil pressure in the supporting cylinders becomes excessive, *B* rises slightly above its neutral position, relieving the excess pressure in exactly the same way as when the oil is being pumped by the bearings. The total movement of *B* for adjusting over the entire range of load is only a few thousandths of an inch.

When the direction of rotation is reversed the operation is just the same, except that the necessary functions are performed by the upper valves instead of the lower ones.

From the foregoing description it will be readily seen that the oil pressure in the supporting cylinders is always exactly in proportion to the torque that is being transmitted. By virtue of this fact a simple pressure gage connected inside of the valve *M* will, if the speed in revolutions per minute be known, indicate the instantaneous load on the gear, so that the Westinghouse reduction gear is not only an efficient transmission device, but a most accurate and sensitive dynamometer as well.

The connections to the pressure gages are indicated at 4 and 5 (Fig. 4). If recording gages are used instead of simple indicating gages, and a graphic speed recorder is connected to the gear, the charts from these instruments would constitute a continuous log of the power transmitted.

The pressure gages may be located in any convenient position, and as far away from the gear itself as may be desired. The direction of rotation is always evident from an observation of which of the two gages is indicating pressure at the time.

If the gages were placed at any considerably height above the gear their indications would have to be corrected for the hydrostatic head of the oil column. Furthermore, if the gages were located at a great distance from the gear there might be some annoyance from leakage, solidification or air pockets in the oil piping. For long-distance indications an ingenious little device has been worked out, which translates the oil pressure to a compressed air supply, which may be conducted

While the Westinghouse reduction gear was originally designed for marine propulsion, in order to harmonize the high speed which is the essential characteristic of an efficient steam turbine, with the comparatively moderate limiting speed for an efficient propeller, its adaptability for other purposes is opening up a field even broader than the one primarily contemplated. The design of direct-current dynamos of fairly large capacities, to operate at the high rotative speeds necessary for direct connection to efficient steam turbines, has always presented difficulties that were seemingly unsurmountable. These difficulties have all been eliminated by interposing the reduction gear between the turbine and the dynamo, so that each element of the combination may operate at the speed for which it is best adapted. Similarly, centrifugal pumps for large capacities at moderate heads are not at all suitable for direct turbine drive, but turbine and pump may be connected through the reduction gear constituting a highly efficient and attractive unit. Naturally, for this sort of service

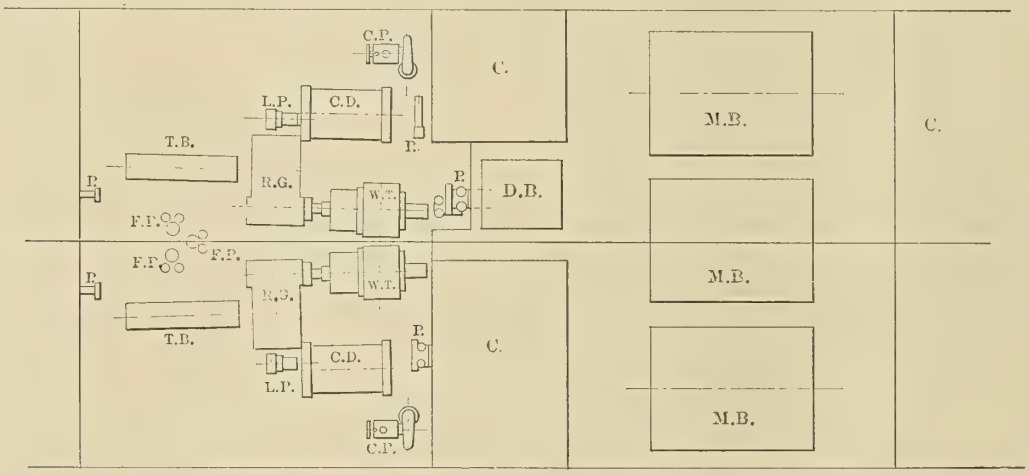


FIG. 6.—MACHINERY ARRANGEMENT OF THE U. S. COLLIER NEPTUNE, EQUIPPED WITH THE WESTINGHOUSE REDUCTION GEAR.

to the pressure gages wherever they may be located. This translating device is indicated by *O* (Fig. 3).

Fig. 5, a section through the floating frame and pinion, illustrates the simple way in which the lubrication of the gear teeth is accomplished. The frame encloses the pinion except for a portion of the circumference where the teeth engage with those of the larger gear. From the passage 6, lubricating oil passes to the pocket in which the pinion is located. The shape of this pocket is such that the oil cannot run out, but must be picked up by the teeth of the pinion. The oil, when picked up by the pinion, is thrown off again by centrifugal force, but owing to the construction of the frame it can escape only by being discharged directly into the teeth of the large gears just at the point of engagement.

In Fig. 1, at the left of the casing, is shown a bracket, through the upper end of which is a screw-adjusted strut bearing against the pinion frame. A similar bracket and strut (not shown in the illustration) are located at the other end of the casing. These struts are for adjusting and maintaining constant the depth of engagement of the gear teeth. They do not interfere with the movement of the pinion frame in a vertical plane.

In order to obtain a flexible drive between the turbine and the gear, and at the same time to keep this gear in close proximity to the turbine, the pinion shaft is made hollow, and the driving shaft passes freely through this bore and is connected to the pinion shaft at the end furthest away from the turbine. This is an old and fairly well-known construction, which has been incorporated on account of its making the apparatus more compact, and not because any novelty is claimed for it.

in which the direction of rotation is never reversed only one set of balancing cylinders and regulating valves is required. These are only two out of a large number of new opportunities for the steam turbine that will present themselves as soon as it is realized that the handicap of inherent high rotative speed can be removed by a thoroughly reliable and durable system of gearing having an efficiency of over 98½ percent, and that such a system is now an accomplished fact.

In addition to the two 4,000-horsepower gears installed on the United States ship *Neptune,* twelve 1,000-horsepower and 2,000-horsepower sets have been sold for driving direct-current generators and for other purposes. A number of these have already been in service for some months, running at speeds as high as 3,600 revolutions per minute, with results that are most gratifying in every particular.

The annual report for 1910-11 of Lloyd's Register of Shipping states that during the past year classes were assigned by the committee to 616 new vessels whose registered gross tonnage amounted to 1,098,476. Of these vessels 544 of 1,089,123 tons were steamers and 72 of 9,353 were sailing ships. Of the total, 65⅜ percent were built for the United Kingdom. As compared with figures for the preceding twelve months there was an increase of 165,420 tons in steamers and 3,110 tons in sailing vessels. Fifty-four of the steamers were over 5,000 tons and five of them over 10,000 tons. At the present date there are several vessels of over 10,000 tons being built. The ships now under construction to the societies' classifications aggregate 1,198,792 tons gross, of which about 16 percent is being built abroad.

VENTILATION OF PASSENGER SHIPS.

BY ANDERSON MACPHEE.

The efficient ventilation of ships where large numbers of people are congregated is of the very first importance. Looking back through the comparatively small stretch of twelve years, when the writer made his first voyage as a marine engineer, and comparing what was considered ventilation then with what is now demanded by a better educated people, one must concede that there has been a great improvement. In the old days when passengers went "below" they were greeted by odors of engine grease, cooking, etc., that sent all but the most inured hasily on deck again, and getting one's sea legs really should have been called getting one's sea nose.

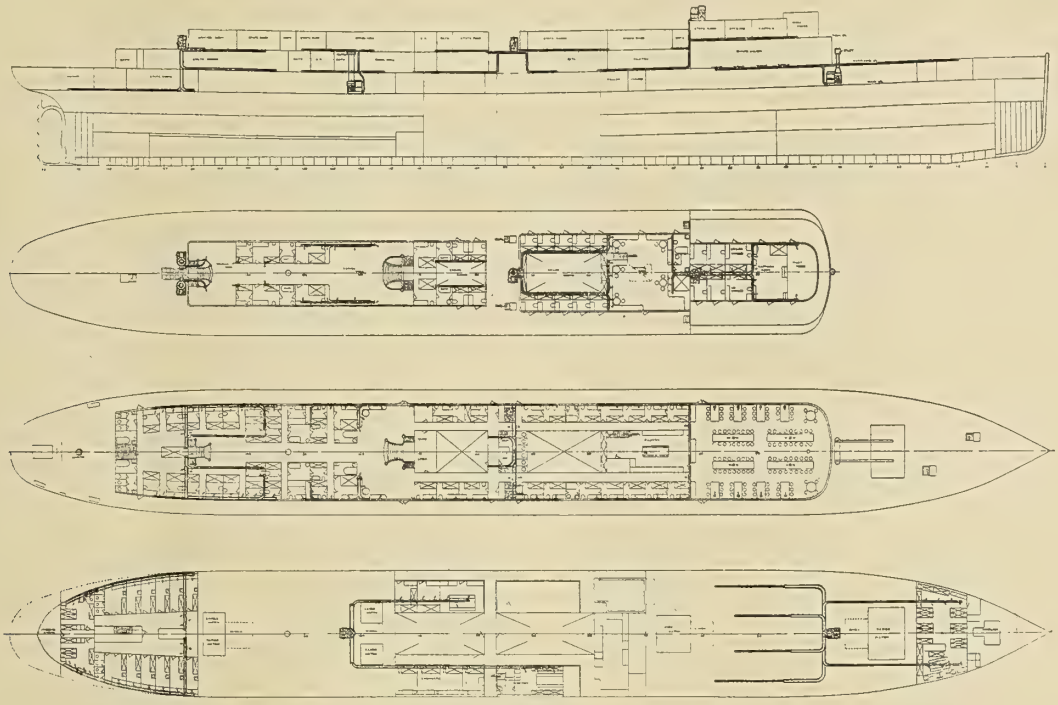


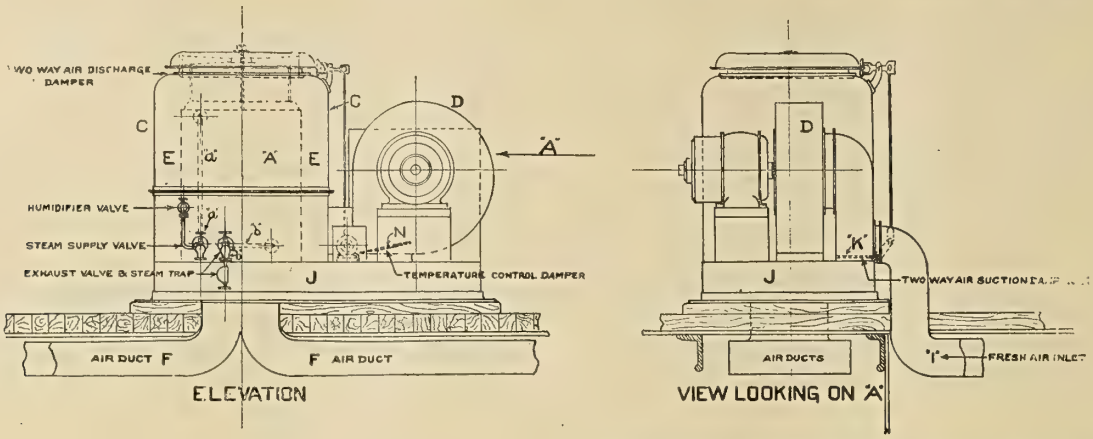
FIG. 1.—TYPICAL ARRANGEMENT OF HEATING AND VENTILATING A FIRST-CLASS PASSENGER STEAMER.

When electricity became more common, fans were installed in the cabins and saloons, but, while imparting a sense of comfort, these only serve to stir the air up and do not ventilate. There is no longer any excuse for these objectionable features, as, with the facilities now at our disposal, every passenger ship should be equipped with some system of supply and exhaust ventilation, combined in such a way as to eliminate all foul or vitiated air and, at the same time, maintain a comfortable temperature. This is easily accomplished by putting all kitchens, pantries, lavatories, etc., under exhaust, the latter being heated by the warm air drawn from their surroundings.

The writer was privileged in his connection with "The Thermotank Ventilating Company," of Glasgow, to design, superintend the installation of, and test many such ventilating equipments for ships, among which are the well-known liners *Mauretania* and *Lusitania*. During the first two voyages of the Italian immigration steamer *Ancona* between Genoa, Naples, New York and Philadelphia he acted as guarantee-engineer for the company, and instructed the ship's crew in the operation of the thermotank system, and it was in acting in this capacity that various improvements suggested themselves. The system is designed to be used either as a plenum system when heating or as an exhaust system when no heating is required. In immigrant ships, transports or war vessels, where large numbers of people are congregated, there are many advantages in being able to reverse the air currents by changing from supply to exhaust. At night the supply system may be used to heat and ventilate the compartments; then, during the day, the exhaust may be used for a time to more thoroughly clear out all impurities in the air. In numerous tests made under regular sailing conditions on the *Ancona* this proved to keep a very much purer atmosphere, the percentage of carbon dioxide and other impurities being much lower than when the supply was on day and night. Several times during the voyages, however, machines were found to be neither exhausting nor supplying air, but simply churning or drawing from the atmosphere and returning again. Difficulty was experienced at times also in maintaining a suitable temperature by the use of the two air-mixing dampers or by throttling the steam at the valve under hand control. At times the compartments were too cold and again too hot, the fluctuations often producing very uncomfortable conditions. These and many other actual experiences led to the design of the ventilating machine known as the thermofan, now put on the market by the Schutte & Koerting Company of Philadelphia.

Fig. 1 shows a typical passenger ship arrangement, illustrating the use of three types of thermofan. The open-deck type, awning-deck type, and 'tween-deck type, and showing the run of the air ducts to the various compartments. These ducts wherever possible should be run at or near to the floor level, not at the ceiling, as is so often done. The reason for this is that the prime object, after considering the ventilating end, is to heat to an even temperature the various compartments. Actual tests have shown that when the heated air enters at the top it remains at the top; in fact, a well-known captain informs the writer that he has found differences as high as 20 degrees F. between the top and the bottom of his room where the duct was at the top; this in mid-winter (Atlantic weather), even where outlets are provided at the bottom of the cabins to the alleyways. Best results are not obtained if the ducts are run at the ceiling.

A further point to be considered in the air distribution is the difference of temperature between inside and outside staterooms. There are two successful methods of dealing with this problem. One is to run separate ducts to inside and



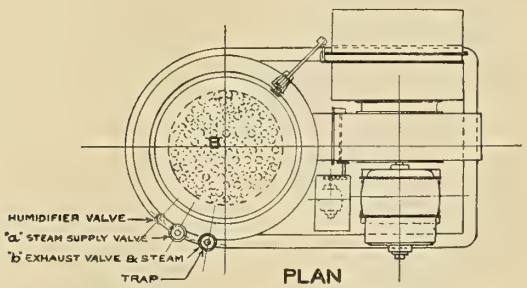


FIG. 2.—OPEN-DECK TYPE THERMOFAN.

outside rooms, each under separate control. The principal objection to this is that it complicates the construction of the thermofan, or multiplies the units. The better method is to equip the outer rooms with auxiliary electric heaters, the efficiency in heat being thus made up at will by the occupant, or these electric heaters may be put under thermostatic control so that they only operate when actually required, thus making a great saving in electric current without interfering with the supply of fresh air in any way.

The design of the ducts is a matter to which little, in the way of theory, can be applied, each individual case having to be treated from a different standpoint. Only experience can teach the engineer how to deal with that problem on shipboard. Speaking generally, velocities up to 2,000 feet per minute are permissible, but only rarely above. The great difficulty is to strike the happy medium between the large ducts with low velocities and the increased horsepower required when the ducts are small and velocities high. In a well-designed layout all the unsightly features of the exposed ducts can be taken care of in architectural features.

There is one more point in connection with the run of the ducts which must receive careful consideration, and that is the distribution and gradation of the louvers or air registers. Close to the source of supply they must be made small, and yet, if made too small, drafts will be set up owing to the high velocity of the air leaving the louver. The writer has found a range of from 8 square inches to 30 square inches in six sets all that is necessary to meet the varying conditions. These louvers at the same time must be adjustable, so that on test they may be set to their correct position, otherwise one compartment is liable to have too much air to the detriment of some other. The question of humidity now arises. In most

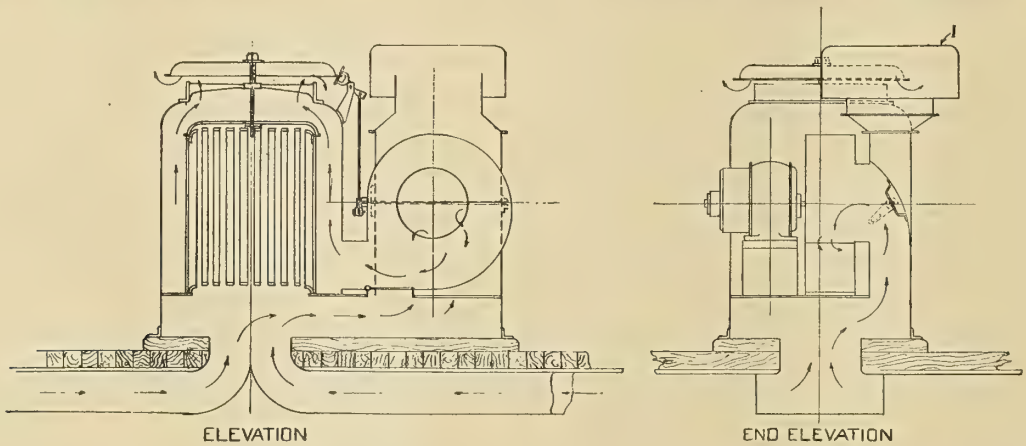


FIG. 3.—SHELTER-DECK TYPE THERMOFAN.

heating systems, both on land and sea, this matter is left severely alone, to the great discomfort and loss of health of the occupants. Dealing with this question brings us to the actual description of the machine.

As already mentioned, there are three types designed so as to suit the varying locations available on shipboard. Fig. 2 illustrates the open-deck type, and this may be taken as typical of all three, the modifications in design for the awning and 'tween-deck types being illustrated in Figs. 3 and 4. Referring to the letters: *A* is the heater which is cylindrical; steam is led into it through the stop valve and piping *a;* the condensed

water is taken off through the steam trap and exhaust valve *b*. The heater is surrounded by a sheet steel casing *C*. Air is drawn from the atmosphere through the intake duct *I*, is directed to the fan *D* by the damper *K* and discharged into the annular space *E*. It is heated by contact with the shell in its upward passage and further heated in its downward passage through the tubes *B*. The fan *D* is constructed with two-way discharge controlled by the damper *N*. When *N* is in its lowest or horizontal position all the air is discharged through the heater. As *N* is gradually moved towards the vertical position, part of the air is discharged into the mixing chamber *J* without being heated; thus by adjusting the position of damper *N* any temperature of the air desired can be discharged through the distribution ducts *FF*. The damper is moved by a quadrant, which is geared to a small motor of about ⅛ or ¼ horsepower. A reversing switch operated by the thermostat already referred to controls the motor. Any variation in the atmospheric temperature immediately puts the motor into operation and supplies more cold or more hot air as required. In place of the small electric motor a steam cylinder may be used to operate the damper, the movement of the piston being under control of two electric solenoids which open and close the steam ports.

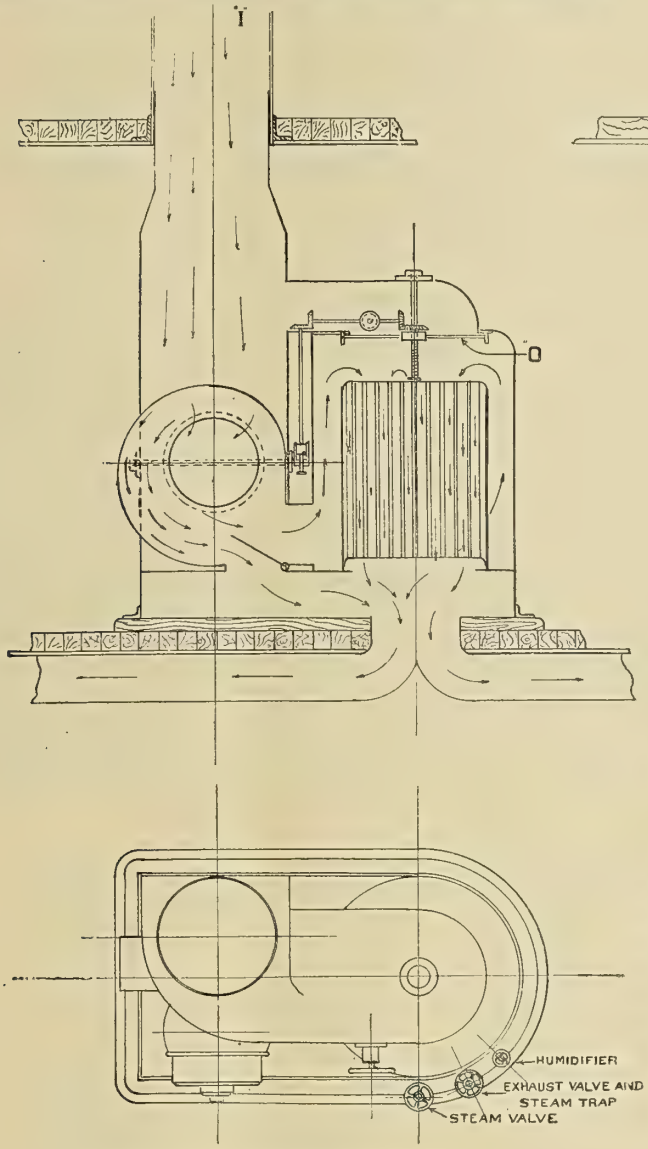
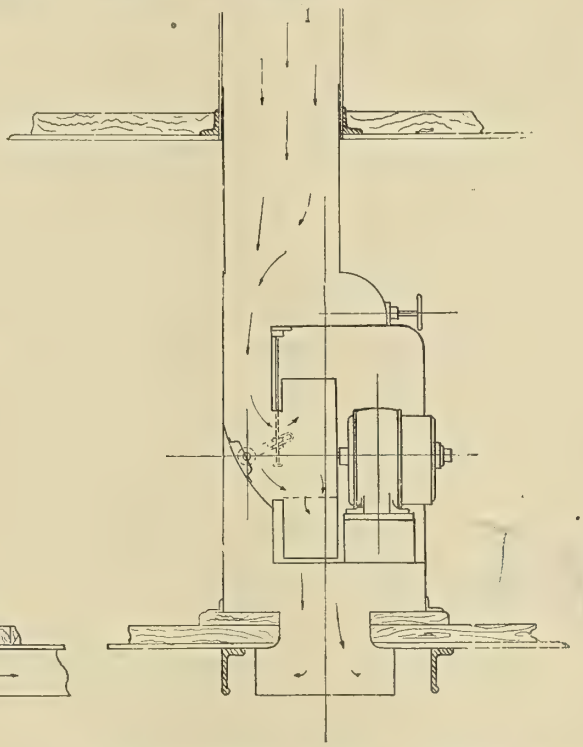


FIG. 4.—'TWEEN-DECK TYPE THERMOFAN.

The thermofans are designed in various sizes, delivering 1,000 cubic feet of air per minute to 10,000 cubic feet; the delivery, however, of each machine can be varied by regulating the speed of the fan motor, the motor in all cases being supplied with finely-divided regulating rheostats. The reason for making this rheostat in fine divisions is because a slight increase in the speed of the fan means a very considerable increase of the volume of air delivered, or a slight decrease in the speed of the fan means a considerable decrease in the volume of air delivered.



THE LARGEST NAVAL COLLIER IN THE WORLD.

BY K. G. MARTIN.

Productions of the great Cramp ship-building yards are ever of interest to those who have aught to do with maritime affairs, and therefore a unique and most successful naval unit constructed in the face of predictions of disaster should be worthy of closest study by the individual, be he naval architect, mechanical engineer, one interested in the efficient and rapid handling of material, or one imbued only with the thought that here is another instance of American supremacy. When the United States government asked for bids on a collier of capacity exceeding that of any before constructed, the Cramp Company made their proposals together with competing companies who usually bid on government work. Proposals for the construction of smaller colliers had already been made to the United States government, but this was the first one of so large a capacity. The Cramp Company then asked for bids from the various coal-handling apparatus concerns, and after careful and extended consideration selected the system specified in the tender of the Mead-Morrison Manufacturing Company, although this was by no means the lowest price quoted for the required installation. The selection of this system was no less a compliment to the Cramp Company than to the manufacturers, for it was unproven in naval work, and it was necessary for the ship constructors to foresee the possibility of successful application of the conveying mechanism to this gigantic floating coal mine.

The bid of the Cramp Company having, after due deliberation, been accepted by the government the construction of the ship was commenced, and in October, 1910, she was placed in commission. The largest collier built up to this time had an ultimate capacity of 7,500 tons of coal, and as the *Cyclops* was

to carry 12,000 tons, one of the points receiving a great deal of attention was its ability for deep-sea work under adverse conditions. That the best possible distribution of weight to meet the varying conditions between full and no load, and that efficient methods of overcoming these variations are provided, was demonstrated by the exceptional behavior of this vessel during a very rough passage to Denmark. Water ballast tanks are used, and by means of the fore and aft conveyor bucket, coal can be transferred from one end to the other, and thus trim the ship and relieve undue stresses.

The photograph of the entire ship shows the ample freeboard with a full load. The derrick poles, booms, etc., which look so solid and heavy are actually very light, being modeled on the latest bridge and building box-girder types, possessing great stiffness and rigidity without superfluous metal. The over-all length of the *Cyclops* is 542 feet, the beam 65 feet, and the depth 39½ feet, so the vessel can follow wherever the battleships go and coal from any regular dock or wharf. Reciprocating engines of 7,200 indicated horsepower drive the collier at a normal speed of 14 knots, although this has been exceeded even when fully loaded with a total displacement of 19,360 tons.

FIG. 1.—NAVAL COLLIER CYCLOPS.

The coal is distributed in six holds of 1,743 tons capacity each, and in bunkers of 2,042 tons capacity, from which the ship takes such coal as she needs for her own steam. The forward hold is divided into four compartments, in which either oil fuel or special coal can be carried for the use of submarines or torpedo boats. Should the bunkers become exhausted, coal can be conveyed by the fore and aft trolley from the main cargo holds to the bunkers. The handling apparatus comprises twelve units, identical in construction and capacity, each operating over a hatch to the hold, two hatches being fitted to each hold. Over the bulkheads separating the holds a mast is fitted, carrying at the sides a pair of booms, the opposite booms at each side, parallel to the beam of the ship constituting the unit. On the cableways between these booms travels a bucket of the clam-shell type, which may be made to discharge vertically at a distance of 22 feet from the side of the ship. Greater distance may be obtained by "shooting" the coal exactly as with a hand shovel and with approximately the same degree of accuracy. A fore and aft bucket is also employed to shift coal from hold to hold for trimming the ship or for supplying certain holds in case only one or two can be brought into use.

While not on the official records of the Navy Department it is of interest to note here that on the occasion of the rough voyage referred to above the captain's meals, including liquids, were several times sent forward to him on the bridge in this bucket when he did not wish to leave his post and go aft. In quickly answering calls to different parts of the vessel the crew often make use of the same conveyance, and these points speak well for the steadiness and smoothness of operation of the apparatus. It may be from this idea that the new transports are being equipped with moving stairways between decks and with moving platforms or gangplanks at the sides for rapid handling of troops and their equipment.

All the buckets on the *Cyclops* have a capacity of 48 cubic feet, 1 1/5 tons of coal, and, operating simultaneously, are guaranteed to unload the 12,000 tons in ten hours; but this figure is merely comparative, as one unit delivered 76 tons in twenty minutes to government specifications regarding handling, height of lift, distance of travel, etc.; this being a record for such service. The cross-deck buckets usually handle from 100 to 180 tons an hour, making three round trips a minute, the fore and aft bucket doing about half of this because its run is longer. All the hoist engines are steam operated, the hoist end being large and the trolley end smaller, a high efficiency in steam consumption thus being obtained. In steaming order the booms are drawn down and crossed lengthwise of the ship, and all cables are lashed fast, but so carefully have details been handled that the vessel can be "cleared for action" in a very short space of time; in fact, this placidly puffing, caterpillar-looking affair has been transformed into a roaring, seemingly chaotic volcano, vomiting coal at the rate of almost 8 tons a second, within the space of fifteen minutes. This rate, of course, can only be maintained as long as the buckets can drop into coal of sufficient depth to get a full load.

The complement for operating the ship itself consists of thirty officers and men, and the coaling end takes thirty more, while on a war footing the total amounts to 200, including reserves, marines, gunners, etc. Searchlights are always in position for night work, and provision is made for a light battery to be installed in the event of hostilities to repel boarding parties and torpedo attacks.

The steam winches for lifting and trolleying the buckets are each operated by one man at the present time, although it was successfully demonstrated that one man could handle both engines from a single point, and it may be that future colliers of this type will have one-man control. This has not been possible on previous colliers owing to the lack of accurate control of the bucket, and consequent injury to its own men and equipment and those of the war vessel and scattering of coal. Some battleships of the older types can only coal by

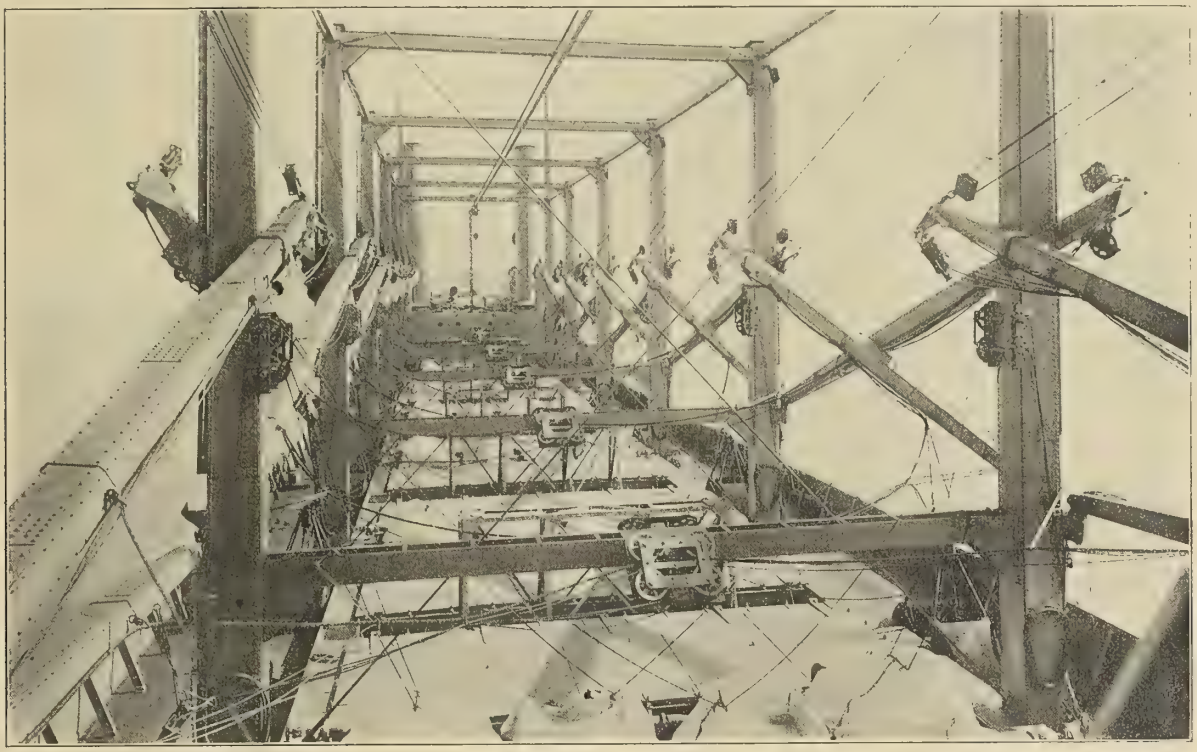


FIG. 2.—DECK ARRANGEMENT OF THE COLLIER, LOOKING AFT, SHOWING THE COAL-HANDLING MACHINERY.

bag, but the change from bucket to bags is made in less than twenty-five minutes. Thermometer readings of coal temperature in the holds can easily be taken through tubes located at the points of greatest heating.

Thus the *Cyclops* is prepared to accompany or meet a whole fleet and supply it with fuel, the capacity of the present-day warship usually making up such a fleet being from 500 to 2,000 tons of coal, and in effect takes the coaling station to the fleet instead of the fleet having to run to the station with added loss of fuel, the capacity of this collier being equal to many naval coaling yards.

It can also run in between a ship and barge or pile and

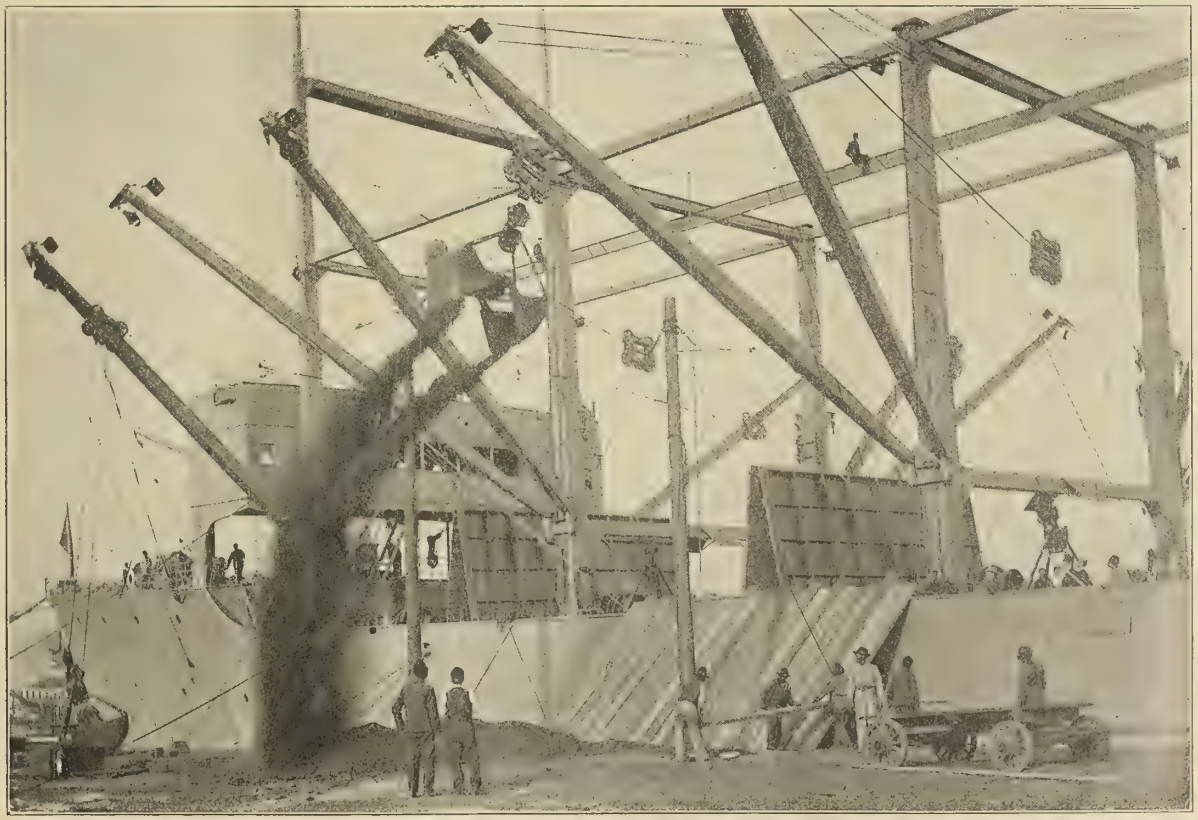


FIG. 3.—"SHOOTING" THE COAL FROM ONE OF THE CLAM-SHELL BUCKETS ON THE CYCLOPS.

transfer the load without affecting its own supply in the holds as well as to supply the ship direct when at sea.

That all this has been accomplished with the regular standard apparatus, except wherein the government called for parts to be made to its special specifications, should be a matter of considerable satisfaction to the Mead-Morrison Company, and after a year in service is meeting with the approval of those severest and most able critics—the men who have to do with the actual handling of the ship.

Several English writers upon naval affairs have questioned the advisability of constructing colliers of such large capacity, pointing out that naval bases are being increased in size and number, and that oil-burning vessels must be looked forward to. Naval bases, however, have a way of being far off in time of need, and are discouragingly stationary. Nor do war vessels venture near them unless pressed very hard for fuel, as their movements are thereby more easily forecasted and their definite location for some time determined by the watchful agents of the opposing power. The oil burners may loom up for a time but the internal-combustion engine is more likely to be the next big step, and in either case the problem of handling liquids is a simpler matter. At the present time the dreadnought can barely make the run from England to China on her own bunkers; and suppose, then, that she cannot be met by a ship able to fully coal her in a short time, but has to go quickly into action with a carefully ambushed coaling station awaiting her as a choice? A collier can dodge, a coaling station can't. And perhaps as answering these critics officially the specifications now being drawn up by the government have been largely influenced by the behavior and capabilities of the *Cyclops,* constructed for $900,000 (£185,000), as against $1,500,000 (£308,000) for previous smaller, inefficient colliers.

CHAIN AND ROPE TOWAGE ON GERMAN RIVERS.

BY K. DIETZE.

(*Continued from page* 439.)

The towing service on the Main is shared by two companies. On the short lower reach of the river the Actien-Gesellschaft Main-Kette has three chain steamers of about 130 indicated horsepower at work, which with this power attain a towing speed of about 3.5 miles per hour, while on the upper reach the Royal Bavarian government has carried on a chain towing-service since 1898. The chain towing-steamers on the Main are almost the same as those on the Elbe, the similarity extending in particular to the establishment of turbine propulsive installations (*g* in Fig. 5, page 436) for the down-stream journey, which are also applied to assist the up-stream work, as in the case of the Elbe steamers *Baensch* (Fig. 5) and *Zeuner.* The reason for this lay in the great improvement in the steering qualities of the vessels which the turbines effected, and which the very sharp bends in the river rendered necessary. Here, also, the engine room for the driving machinery of the winding machinery and turbines and the condensing installation are arranged in the middle of the vessel in each case. Forward of these are the boilers and bunkers, and abaft them, supported by a bulkhead, the turbines *g.* The foremost and aftermost spaces are utilized for the accommodation of the crew (as in Fig. 5).

The gripping wheel *m,* designed by Bellingrath (Figs. 5, 6 and 7), is also made use of here. On account of the severe and greatly fluctuating stresses which the leading-on sheave (*l* in Fig. 5 and *b* in Fig. 6) in front of the gripping wheel has to withstand, it is supported by a stay *b'* (Fig. 6) with a spring buffer and fork. Chain lockers, lined with wood, before and abaft the gripping wheel prevent any chaffing of the bight of the off-going chain against the steel parts of the vessel. The axle of the drum, made of the best quality of steel, rests in a cast steel framework, which is attached to heavy-built girders at the bottom and at the deck of the vessel. At the top the whole is covered over by a plated hood. The towing hawser is led over a horizontal roller, and held fast by blocks which are attached to spring buffers.

A double cast steel tooth-wheel gearing, with a ratio of 1 to 10, connects the gripping-wheel with the engine, on the crankshaft of which is mounted a brake-sheave operated from the deck. This enables the engine to be held in check in case of fracture of the chain or while the tug with the barge train is lying at anchor. The chain-engine is of the horizontal twin compound description, with the well-known tandem arrangement of the cylinders. The plummer blocks, guides and cylinders are attached to the bottom girders of the vessel separately, and are well stayed to one another to enable them to take the stresses to which they are liable. The crankshaft, with the two cranks set at 90 degrees with each other, rests in three bearings. The connection with the winding gear is formed by a flange at one end of the crankshaft, the other end taking the fly-wheel, which is provided with eccentric weights in order to compensate mass action. With a 50 percent admission of the high-pressure cylinder and a speed of 150 revolutions, the engine indicates about 130 horsepower. At a towing speed of from 3.5 to 5.5 feet per second it can exert a pull of 4 tons.

Each cylinder has an ordinary flat slide valve. In addition each low-pressure cylinder is provided with an auxiliary slide valve, by means of which the engine can be started when subject to a heavy load. The admission at starting is for the same reason set at 78 percent, which is reduced to 50 percent after the desired speed has been attained. The Klug reversing gear is operated from the engine room by means of a separate hand-wheel with vertical screwed spindle.

Each of the main turbines (Figs. 5 and 8) is driven by an independent vertical compound engine of the ordinary pattern, with Klug reversing gear, which can be operated by means of a hand lever. Under ordinary conditions of working this engine is not reversed. Reversing is resorted to only when it refuses to start or when the water-supply channels *c* (Fig. 8) to the turbines are to be scoured out. On the steamer Baensch (Fig. 5) horizontal reciprocating engines are fitted for actuating the turbines. The condensing installation is for the three engines in common, a slow, even starting of the winding gear being thereby attained. The independent steam flooding pump is a two-cylinder, quadruple-acting Worthington.

Special interest attaches to the turbine installation *g* (Figs. 5 and 8) on the *Zeuner* principle, which, in order to improve the steering qualities of the vessel, is sub-divided into two independent aggregates arranged at the sides of the vessel. The principal dimensions of each turbine are as follows:

	Inches.
External diameter of the working wheel	34
Diameter of the nave of the working wheel	17.5
Number of blades of the working wheel *a* (see Fig. 8)	15
Number of blades of the contractor *b* (see Fig. 8)	16

Viewed from aft the port engine turns in the direction of the hands of the clock, and the starboard engine in the opposite direction. The water enters the supply channels *c* (Fig. 8) through the grated low-lying openings *c'* (Fig. 8), and is led through a system of guide plates *d,* which form a continuation of the contractor blades *b* to the turbine blades *a.* Here it is accelerated and pressed through the blades of the contractor *b,* after which it is led back outboard through the exhaust channels *e,* and ejected in a direction parallel to the longitudinal axis of the vessel. The blades of the turbine and of the contractor are of steel, and are cast into the bronze bosses. The turbine shaft is taken at one end by the fixed contractor *b,* and at the other rests in a bushed bearing in the supply channel *c.*

To give sternward motion to the vessel the direction of the

outflowing jet of water is, by the aid of a rotating elbow piece *f* (see Fig. 8), reversed, the water being pressed through a reverse jet pipe *h* that is fixed to the vessel. The manipulation of this elbow piece can be effected from the deck for the two engines at once, or for each of these independently by means of hand-wheels and spindles *u* (see Fig. 5), by which the necessary good steering qualities are insured to the vessel. The jet pipes *h* are protected by considerable extensions of the breadth of the deck *v* (see Fig. 5). With the turbines the vessel attains a down-stream speed of 9.3 miles per hour with a 1.86-mile current and a power development of the turbine engines of 65 indicated horsepower each, with from 225 to 250 revolutions per minute and a 50 percent admission of the high-pressure cylinder.

For all the engines of each of the Main vessels the steam, of

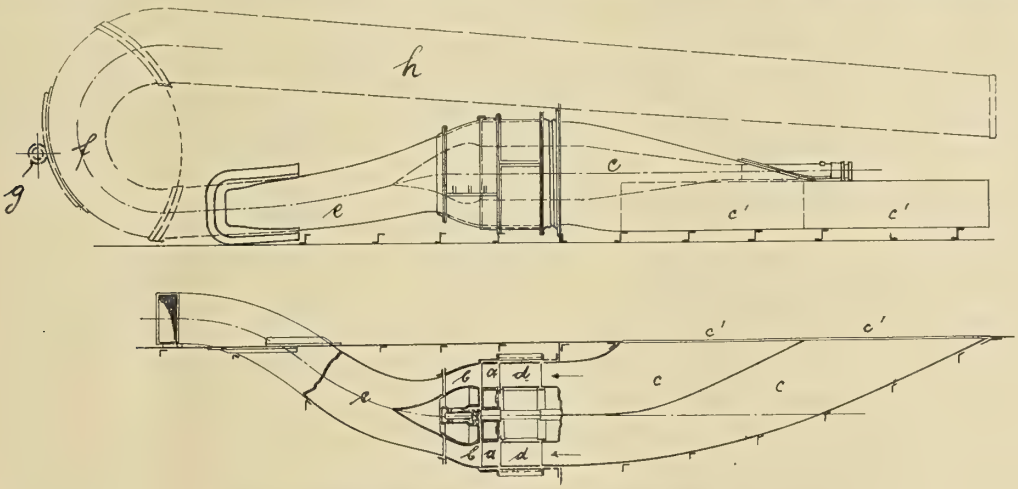


FIG. 8.—PROPELLING WATER TURBINE ON A CHAIN TUG.

147 pounds working pressure, is supplied by an ordinary cylindrical, direct-flame boiler, with a dome and two furnace tubes. The heating surface is 600 square feet and the grate surface 19 square feet. The river water used for the feed is taken direct through the skin of the vessel by the aid of two injectors. An independent Worthington pump leads the condensed water from the air pump to the boiler, so that the main engine is free of all separate pumps.

The coal consumption amounts to about 55 pounds per mile run by the vessel per hour. The newer steamers for the Main work with superheated steam (300 to 320 degrees), and are fitted with Schmidt superheaters. The installation of the chain towage-service on the 125-mile stretch of the Upper Main is stated to have cost $550,000 (£113,000), while the regulation of the river over the same distance cost $800,000 (£165,000).

Not very long after the introduction of chain towage the rope towage-system also made its appearance on the Rhine, where it was well suited to the peculiarities of the river and soon made its way. In 1871 the Central A. G. für Tauerei und Schleppschiffahrt took its rise in Cologne (at a later time in Ruhrort), with the intention of conducting a rope towage-service between Emmerich and Strassburg. After several experimental trials made on different reaches the service was confined to that between Bingen and Rungsdorf (75 miles), on which a number of rapids occur. In 1905, however, when the regulation of the river was becoming very far advanced, and the competition of the paddle and screw tugs had in consequence become insupportable, the service was finally abandoned.

The idea of rope towage arose in France, and was very quickly taken up. Except on the Rhine, however, it was never adopted in earnest in Germany; such services as were instituted were soon given up, although men of authority for the most part characterized the rope system as an improvement on that of chain towage. The above-mentioned company employed eight towing vessels (Tauer) with an aggregate of about 1,400 indicated horsepower. These make use of the rope only in up-stream work, at the end of which they release the rope and proceed down-stream with separate engines driving ordinary twin screws, which, on account of the considerable drafts of water possible in the Rhine, can work economically. These conditions give the rope towing-vessels (Fig. 9) a different outward appearance. The necessity for throwing off the rope entails the arrangement of the heavy winding gear at the side of the vessel, bringing with it a number of unpleasant consequences, such as a strengthening of the hull, which is also subjected to lateral stressing, as also impairment of the steering qualities, etc. At any rate, rope towing-vessels with the rope led along the center lines of their decks have not proved satisfactory. Since, however, the disconnection of a rope is not nearly so simple a matter as that of a chain, the rope towing-vessels *must* be in a position to set themselves free for the down-stream journey in order to pass each other. The institution of a separate rope for the down-stream journey would also, apart from these considerations, be undesirable, for the reason that, especially during the down-stream journey of a vessel without train, the not very flexible rope would be subjected to very little stress, and, on account of the insufficient friction thereby set up, would be liable to spring off the wheels, and thus cause constant interruptions of the work. Like the chain tug the rope tug also has a downward sheer forward so as to leave room for a considerable lateral movement of the rising rope. Wooden transverse bow pieces prevent the rope from fouling the deck fittings. The form and arrangement of the afterbody thereby is much the same as in other vessels. Good steering is ensured by the presence of two rudders—one 8.5 and the other 9.75 feet in breadth—which are worked from the bridge by means of rods and chains. The whole of the midship part of the vessel is taken up by the engines, boilers and bunkers, the spaces before and abaft these being utilized for the accommodation of the crew. The principal dimensions of the rope vessels are the following:

Length over deck	150 feet.
Length between perpendiculars	138 feet.
Breadth, molded	24 feet.
Depth, molded, amidships	8.2 feet.
Draft	3.1 feet.
Displacement	209 tons.

The wire rope passes first over a large reception guide-wheel *a* (Fig. 9) of 9 feet in diameter, which can move

freely in a lateral direction. For this purpose the latter is mounted on a flap, which is free to turn round the axis *bb*. This axis is inclined in such a way that it touches the periphery of the wheel *a* and that of the following guide-wheel *c*. In every lateral position of the wheel *a* the leading of the rope into the plane of the wheel *c* is thus ensured. The wheel *a* then has the same functions to perform as the outrigger in the chain steamers. The axle of the wheel *c* has a fixed mounting on the hull. The diameter of the wheel *c* is also 9 feet. It is fixed in such a low position that the rope runs with a vertical lead onto the rope drum proper, *d*. Since the rope passes down to the end wheel *e* in the same manner, it girdles the upper half of the periphery of the rope drum *d*. The guiding end wheel *e* (7.5 feet in diameter) is mounted in such a low position that when the rudder is put over and the course of the vessel lies inclined to the direction of the rope, the latter does not come in contact with the bottom of the vessel. In like manner to the reception guide-wheel *a*, the off-leading guide-wheel *e* is supported by a flap, which, though in less degree than the wheel *a*, is free to move in the lateral direction round the axis *ff*.

The rope drum *d* is one of the well-known Fowler flap drums, and works in the manner that pairs of opposing flaps in the hollow of the tire of the wheel lay hold of the rope with a grip corresponding with the tensile stress exerted. From this it will at once be seen that a large proportion of the section of the rope must be discounted for wear occasioned by these flaps, while on the other hand, the advantages attaching to the Bellingrath chain grip-wheel, that the rope drum is engirdled by the rope over only a part of its periphery, remains. Other methods of holding the rope have also been proposed, such, for instance, as the "Wernigh" device, which was applied to two rope tugs on the Oder. Somewhat as in the case of the chain, the rope was here led over two driving drums, from which it had, by reason of its light weight and small flexibility, to be led away again by separate mechanism. This latter apparatus consisted in a number of wheels, the tires of which were divided in a direction vertical to the axis. Much as in the ordinary chain grip-wheel, with indentations corresponding with the chain links, these Wernigh wheels were provided with projections and depressions, which corresponded with the strand windings of the rope made use of, and grasped the latter with these when the halves of the wheel were pressed together. The trials made with the Wernigh constructions are said to have given satisfactory results, although the apparatus was characterized as somewhat complicated. The same designer then brought out a new rope sheave with an undulating groove, by means of which, in particular, the wear of the rope was considerably reduced. At the same time this new design brought the advantage that the rope could be led along the center line of the vessel as in the case of the chain. Information as to the manner in which the vessels made their down-stream journey has not been obtainable, but at any rate such vessels have been on service on the Lower Rhine with good results.

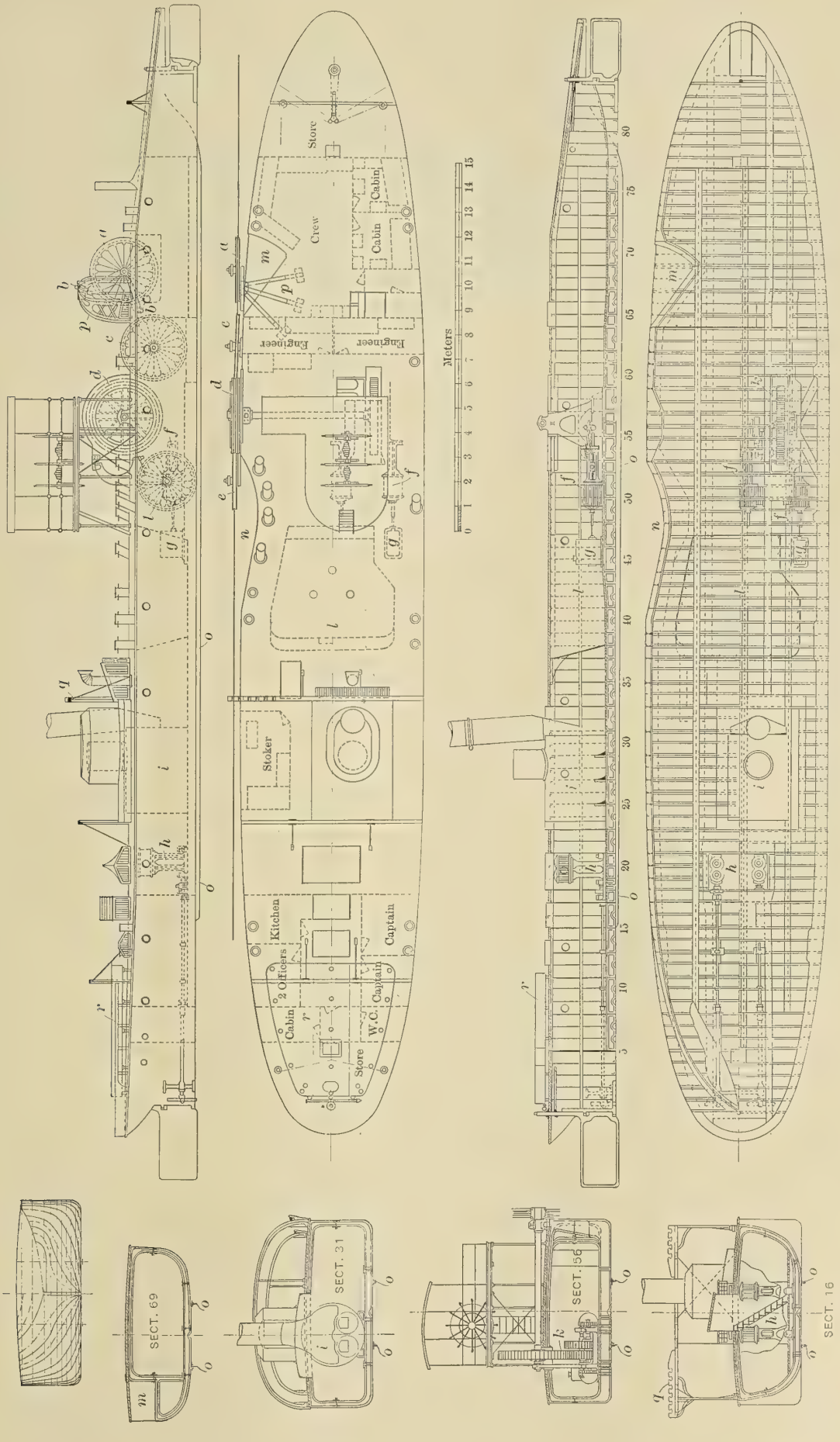
The flap drum that is principally in use on the Rhine has a diameter from center of rope to center of rope of 10 feet. It is mounted at the side of the vessel, and is actuated from the engine by a two-grade gearing with a reduction ratio of about

$$\frac{51}{20} \times \frac{102}{22}.$$

The driving engine *f* (Fig. 9) for the drum is a twin-cylinder engine of 160 to 180 indicated horsepower (diameters of cylinders of each engine 14.5 inches and stroke 24 inches), making about 80 to 100 revolutions and working with jet condensation *g*. It differs, however, in arrangement from the engines of the chain tugs on the Main, in having one of its cylinders at each end of the winding gear. Cylinders, slideways and crankshaft bearings rest on a cast iron bed-plate in common, on which also the heavy seat for the drum axle is mounted (see Fig. 9). One of these half engines at the same time drives the pumps, while the condenser air pump *g* is connected in tandem fashion with the other. The engines are not provided with means of reversing, which also, in presence of the separate propulsive engines, is not absolutely necessary. The *Tauer No. 3* can tow a train of 5.5 tons at a speed of 4.5 feet per second, thereby developing 145 indicated horsepower.

As already stated, two twin engines *h* each drive a screw 3.8 feet in diameter, with which a speed of 9.3 to 11 miles per hour is attained on the down-stream run with a tow-train of four empty barges. An ordinary return-flame cylindrical marine boiler *i*, with dome, supplies the steam for the whole engine installation. The working pressure is about 100 pounds, and the consumption of coal about 3 to 3.3 pounds per indicated horsepower per hour. A funnel-shaped coal bunker *l* is built into the vessel in such a manner that it is possible to get past it from forward to aft at each side of the vessel.

The hull of the vessel herself is built of steel, and is similar in its general structure to that of a chain tug. It differs from that of the latter, however, in that its bilge is rounded off throughout, and in certain structural alterations rendered necessary by the removal in this case of the winding gear with the large cast metal rollers to the side of the vessel. In order to enable the high-lying receiving wheel *a* to be swung out to a sufficient degree the side of the hull had to be provided with a recess *m*. To this end the side was drawn in up to a point a little below the wheel, and the deck cut out in a segment so as to form an open niche made watertight against the hull by plating. The hull has a further recess *n* for its full height abaft the low-lying off-leading wheel *e*, so as to admit of a lateral motion of the latter. The recessing of the hull required for the extreme lateral movement is swept in an easy curve back into the normal form of the vessel. Specially worthy of note are two bilge keels *o* of from 4.8 to 7.2 inches in height, which are worked under the vessel at a distance of 4.25 feet from each side of her center line and carried up forward. They serve the purpose of keeping the rope free from the bottom of the vessel in case of strong weed formation on the bed of the river, or of a very much inclined direction of the rope in relation to the vessel. The movable swinging axle of the wheel *a* is kept in its place by means of a very strong gallows-like structure *p*, consisting of three built girders, which in their turn are supported below by strong web frames. A similar structure, which, however, could be kept very much lighter, and which accordingly is attached directly to the protective plating of the flap drum, bears the axle of the off-leading wheel *e*. To facilitate the throwing off of the rope and their own eventual dismounting, the horizontal axles of all the rope-wheels have bearings at one end only, as a result of which, it is true, the transmission to the vessel of the components of the pull on the rope becomes very unfavorable. In view of the greatly varying direction of the lead of the rope to the flap drums these forces are in themselves very great, so that there can be no question but that the hull must here be subjected to very considerable local strengthening. Even when the vessel is at rest the large dimensions of the flap drums and leading wheels render the whole winding gear exceedingly heavy; the unsymmetrical distribution of the weights and the recessing of the vessel's side make it especially necessary to strengthen the hull, so that, as already observed, the total displacement, and therewith the draft, must when compared with those of a chain tug, be relatively very great, which again, of course, considerably adds to the cost of the installation. The cheapness of the rope, which is generally claimed as an advantage by the opponents of the chain, is hereby in part made up for. Of



DETAILS OF A ROPE TOWING TUG FORMERLY USED ON GERMAN RIVERS.

interest at this point is the method of leading the tow-rope over a large towing bar *g* (Fig. 9).

It would appear that it had not always been found possible in the designs to give due consideration to the effect exercised by the tension of the rope on the fore-and-aft and athwartship trims of the vessel, for we find in some of the steamers a ballast tank *r* with three longitudinal partitions arranged on the deck at the stern, the object of which is the subsequent correction of lists and improper fore-and-aft trims during the up-stream or the down-stream journey. In other respects the hull presents no peculiarities. The spacing of the frames is 20 inches throughout.

Special arrangements are made at the end points of the rope, in so far that a barge with a heavy winch and a large drum is installed at each of them, for the purpose of regulating the tension of the rope when it is being thrown off or taken up by the tug.

For driving the winding gear of the rope-vessel for the *Danube* (*Vaskapu*), which has already been mentioned, a compound engine of 300 indicated horsepower is provided, which is coupled to the winding drum by a threefold wheel gearing. The revolutions of the rope drum (8.2 feet in diameter) were thereby reduced in the ratio of 30 : 1. The large toothed wheels and the rope drum were made of cast steel. Special apparatus was provided for taking up the rope and for pressing it down as it ran off the last wheel, and another apparatus looked after its regular winding onto the winch. In contrast to the Rhine Tauers the rope was in this case led along the center line of the deck. As in the case of the chain tug it could, for the sake of the steering, be swung laterally (Lombard Gévin Lyon system) by means of separate leading paths at the fore and after ends of the vessel, which were operated from the bridge. It had been found possible considerably to reduce the twist which occurs with special frequency in a wire rope by coiling it onto a drum in the makers' works with a tension of 24 tons by means of mechanical appliances.

A few further particulars of matters of general interest connected with the towing services on the German rivers may be given in conclusion. It is the practice for the towing hawsers for the up-stream journey, to be provided by the tug, while for the down-stream journey the towed vessel must herself carry suitable hawsers. On the Rhine, if the cargoes be less than 350 tons, additions are made to the rates of the towage tariff amounting to from 25 to 75 percent as the amount decreases from 350 to 250 tons or less. Wooden vessels must, in general, pay 75 percent more than others without regard to their size or cargo, while for lighters a lump sum or a special rate per ton of cargo-carrying capacity is agreed upon. The permissible length of the tow-train varies very considerably on the different rivers, and it is often the case, for instance on the Rhine, that each barge in the train is connected by a separate towing hawser with the tug herself. This arrangement offers many advantages in towage work, as, for instance, releasing separate barges and in steering. The abandonment of the rope towing-service is the typical fate of the towing companies on the German rivers. In view of the steadily increasing competition of the railways and the further development of the paddle and screw tugs, combined with the careful regulation of the rivers, the existence of the chain traffic will gradually lose its justification more and more, and as it ceases to pay its field of work will diminish in extent. In countries, however, in which still untamed waterways run through the country unutilized the Tauerei represents an exceedingly cheap method of dealing with the transport of bulk goods.

The Bureau of Navigation reports 108 sail and steam vessels of 10,938 gross tons were built in the United States and officially numbered during the month of October. Seventy-three percent were steamers.

THE AMERICAN NAVAL REVIEW.

From every standard of comparison the most notable fleet ever assembled by the United States was that reviewed by President Taft and Secretary of the Navy Meyer at New York Nov. 2. It involved the greatest number of American vessels ever mobilized, with the greatest total displacement, and represented the maximum in fighting effectiveness probably ever gathered at one point by any nation.

As indicating something of the increased strength of the United States navy it is interesting to contrast the number of vessels and their total displacements which took part in the other important naval reviews of recent years. In the international naval review at New York in March, 1893, there were fourteen American naval vessels of all classes, with an aggregate displacement of 39,436 tons. President Roosevelt, in September, 1906, reviewed, at Oyster Bay, the Atlantic fleet, then comprising forty-five vessels displacing 279,612 tons. During the Jamestown Exposition there was mobilized at Hampton Roads in June, 1907, a fleet of thirty-three vessels displacing 285,251 tons. When the Atlantic and Pacific fleets met at San Francisco in May, 1908, they combined a total of forty-six vessels displacing 407,924 tons, and in September, 1909, at the Hudson-Fulton celebration forty-three vessels were assembled with a total displacement of 316,762 tons. This latest review at New York included 102 vessels of all classes displacing about 577,285 tons, which does not include the eight submarines, of which no figures were available. Concurrently at Los Angeles a review was taking place of twenty-four vessels of 116,000 tons displacement, giving a grand total of 126 vessels displacing 694,000 tons. Perhaps the most striking evidence of progress is, that of all the vessels in the New York review the only ones that were a part of the navy at the time of the Spanish War were the battleships *Iowa, Indiana* and *Massachusetts,* the gunboats *Castine, Nashville, Marietta* and *Petrel,* a few of the small torpedo boats and some of the fleet auxiliaries.

The following table shows the number of vessels of each class in the Atlantic fleet and their total displacement:

	Tons.
24 battleships	366,864
2 armored cruisers	29,000
2 cruisers	6,950
22 destroyers	15,463
16 torpedo boats	2,994
8 submarines	.....
3 tenders to torpedo fleet	8,466
4 gunboats	4,737
9 miscellaneous	40,733
8 colliers	93,938
1 oil tanker	6,159
3 tugs	1,981
102 vessels of all classes	577,285

Exclusive again of the submarines these vessels represent a total horsepower of 946,811, for the supplying of which there are 567 boilers, with an aggregate of 46,360 square feet of grate surface and 2,062,000 square feet of heating surface. All of the battleships, cruisers and torpedo boats except the battleship *Iowa* have watertube boilers. This is an interesting reversal of the condition of affairs at the time of the Spanish-American War, when outside of the torpedo boats there were only four warships then equipped with watertube boilers. Seventeen of the destroyers burn oil as fuel, and the four latest battleships—*Delaware, North Dakota, Utah* and *Florida*—burn oil in conjunction with coal. The fleet has attached to it a fuel oil tankship to carry the reserve fuel oil supply for these vessels, serving the corresponding function of the eight colliers carrying the coal supplies for the other vessels.

THE AMERICAN ATLANTIC FLEET AT ANCHOR IN THE HUDSON RIVER.

The aggregate coal bunker capacity of the fleet is 81,450 tons. Adding to this the coal cargo capacity of the colliers, 58,813 tons, the fleet can sail away with a total of 140,263 tons of coal. Propelled simultaneously at their full power all of the vessels would consume coal at the rate of 20,000 tons a day.

With its full complement the fleet would carry 27,344 men and 1,660 officers, a total of 29,004, and it is safe to say the actual figure is in the neighborhood of 25,000 men.

The average speed of the vessels is 21.6 knots. The fastest vessel is the destroyer *Paulding*, which is capable of a speed of 32.8 knots. Placed end to end, touching, the vessels of the fleet would extend a total length of 29,942 feet, or over 5⅔ miles. If passed in review in single file at an average distance apart of 300 yards the fleet would form a line extending nearly 23 miles, and at an average speed of 10 knots would take about two hours to pass a given point.

It is self-evident what such a fleet as this means to the shipbuilding and ordnance manufacturing industries, but there are also less intimately associated industries that played an important part in the equipment of this fleet. We are advised, for example, by the Blake & Knowles Steam Pump Works, 115 Broadway, New York City, that it has installed pumping equipment on sixty-five of these vessels, which is a large percentage considering that nine of the remainder carry no steam pumps, including the submarines and one sailing vessel, and that eight of the others, principally colliers, were built abroad. The number of pumps this company has installed on the fleet exceeds 1,000, and their cost represents nearly a million and a quarter dollars.

PERSONAL.

Mr. De Courcy May, who has been president of the New York Shipbuilding Company for some years, has resigned the presidency but remains chairman. Mr. Samuel M. Knox, formerly secretary and treasurer, becomes president.

Mr. Robert C. Monteagle, for several years chief engineer of the Atlantic Works, East Boston, has been made assistant manager and engineer of the Lockwood Manufacturing Company, East Boston, Mass.

Mr. C. D. Chasteney has resigned his position as sales manager of the De Laval Steam Turbine Company, Trenton, N. J., having acquired an interest in the Turbine Equipment Company, 30 Church street, New York, which company represents the De Laval Steam Turbine Company in New York State, parts of New Jersey and Connecticut. Mr. Chasteney was graduated from Stevens Institute of Technology in 1901, and has been with the De Laval Steam Turbine Company since the organization of the American company over ten years ago.

A Shipbuilding Record.

The Great Lakes Engineering Works, Detroit, recently delivered in record time a fleet of eleven vessels. On March 17, 1911, contract for these vessels was signed. They comprised four steamers, the *Penobscot, Seaconnet, F. J. Lisman* and *M. E. Harper*, and seven barges, named *Providence, Searsport, Bangor, Boston, Lynn, Portsmouth* and *Salem*.

The steamers are of a uniform size of the following dimensions:

Length over all	261 feet.
Length between perpendiculars	253 feet.
Beam, molded	43 feet 6 inches.
Depth, molded	26 feet 6 inches.
Depth water bottom	3 feet.
Capacity, gross tons	4,000
Engine, triple expansion, 21, 34½, 57 by 42 inches stroke	1,350 horsepower.
Boilers, Scotch, 13 feet diameter, 12 feet 1¼ inches long, 175 pounds working pressure; positive heated draft	2

The barges are:

Length over all	268 feet.
Beam, molded	36 feet.
Depth, molded	22 feet.
Capacity, gross tons	2,650

All of these vessels were built in the yards of the Great Lakes Engineering Company, and delivered before the 1st of October, so as to pass through the Great Lakes and St. Lawrence River in advance of navigation being closed by ice. The vessels were built for the Harper Transportation Company, of Boston.

In addition to this order the company delivered in November for the Atlantic coast two steamers which will trade to Southern ports, the West Indies, etc. These steamers are of the following dimensions:

Length over all	261 feet.
Length between perpendiculars	253 feet 3 inches.
Beam, molded	43 feet 6 inches.
Depth, molded	28 feet 5 inches.
Depth of water bottom	3 feet.
Engine, triple expansion, 1,480 horsepower, 21½, 35½, 58 by 42 inches stroke	
Boilers, Scotch, 14 feet 2 inches diameter, 12 feet long over all, 180 pounds working pressure; positive heated draft	2

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CONGESTION OF FREIGHT TRAFFIC AT NEW YORK STEAMSHIP TERMINALS.

We present herewith three views which show some of the glaring defects of the present arrangement of steamship terminals at the port of New York. The lack of mechanical appliances for handling freight is evident in Figs. 1 and 3. The present cost of transferring cargo could be cut down 50 percent by the use of mechanical cargo-handling appliances, and these would insure greater rapidity and eliminate the re-handling of freight by manual labor. Such features are of great importance when the necessity for overcoming the congestion of freight traffic at the steamship terminals is considered. Rapidity of freight movement, reduced handling costs and increased capacity of existing terminals can be obtained by the adoption of improved mechanical methods.

FIG. 1.—USUAL METHCD OF HANDLING MISCELLANEOUS FREIGHT AT NEW YORK STEAMSHIP TERMINALS.

In Fig. 3 the congestion is very evident, and yet only a small part of the space in the pier shed is being used on account of the impossibility of tiering the freight to any greater height by hand methods. The introduction of mechanical methods of handling freight would permit higher tiering and practically double the single-story pier capacity. The saving in the investment in port installations by high tiering are evident from the fact that usually only about one-third of the floor space is available for storage, and that if the freight is handled by manual labor the tiering cannot be carried above 5 feet, whereas with mechanical handling the tiering could be carried to 20 feet and increase the capacity of the pier in proportion. Congestion is also apparent on the street along the water front, a typical example of which is shown in Fig. 2, where the substitution of motor trucks for horse drays would greatly facilitate the rapidity of moving the freight to and from the piers, besides reducing the cost from 20 to 40 percent.

TRANSFERRING CARGOES FROM SEATTLE DOCKS.

Along the water front in Seattle, Wash., the wharves are constructed of pile piers with slips between them in which sea-going vessels are berthed. Railroad street extends along the water front and separates the docks and piers from the large warehouses. The space provided on the docks is limited and numerous warehouses are provided across the street.

The equipment shown in Fig. 1 was installed for transferring the large volume of miscellaneous freight handled daily between the dock and the warehouses. It consists of an overhead bridge extending from the wharf across the street to the warehouse, which contains an overhead freight conveyor (or flight conveyor, as it is called) traveling 60 feet per minute. The conveyor is 250 feet long between centers.

Fig. 2 shows a view of the wharf and the method of transferring the cargoes directly to the end of the conveyor line. Fig. 3 shows the other end of the conveyor line distributing the filled barrels on the second floor of the warehouse. Wooden conveyor flights, 3 inches thick, 12 inches wide and 36 inches long, constructed of Puget Sound fir, are secured to two strands of 180 Jeffrey steel thimble roller chain, forming practically a continuous apron, on which the freight, such as baled hay, cement in barrels, large packing boxes and the like is carried. At the warehouse end of the conveyor are sprocket wheels, which mesh with the two link chains, and placed on a shaft are geared to a line shaft that is belted to a continuous-speed, alternating-current 10-horsepower motor.

The illustrations show a cargo of cement being unloaded. The ship was docked within 15 feet of the receiving end of the conveyor. The barrels were placed in slings, containing six barrels in a load, and were hoisted from the hold by means of the vessel's derrick in connection with an electric hoist on the dock, which landed the sling load at the foot of the con-

FIG. 2.—CONGESTION IN WATER-FRONT STREETS AT NEW YORK STEAMSHIP TERMINALS.

FIG. 3.—"FULL PIER" IN A NEW YORK PIER SHED, SHOWING SMALL PART OF SPACE OCCUPIED BY HAND TIERING.

FIG. 1.—OVERHEAD FREIGHT CONVEYOR FROM PIER TO WAREHOUSE, AT SEATTLE.

veyor, whence the barrels were rolled directly to the conveyor while it was in motion, the barreled cement weighing 400 pounds per barrel. Over three thousand barrels were readily handled in eight hours, although the maximum capacity of this conveyor is about 1,200 barrels per hour. The handling of this cement required eighteen men at the rate of 27½ cents (1/2) per hour, including all the labor necessary. Under the old arrangement where this material was handled by means of trucks, no less than twenty-eight men were required, thus resulting in a saving of ten men by the use of the conveyor, this saving amounting to $22.00 to $25.00 (£4.5 to £5.1) per day on an eight-hour shift, or at the rate of $56.00 to $75.00 (£11.5 to £15.4) per day on a three-shift basis of eight hours each. The complete cost of the entire outfit, including the necessary alterations at the dock and warehouses, including a new roof, truss and several other incidentals, amounted to approximately $6,745 (£1,380), so that it is readily seen that the conveyor will pay for itself within a short period of time. The conveyor is built so that in addition to handling package freight of any kind it can also be used to transport loose brick, pig iron, sacked sugar and miscellaneous freight.

This conveyor system was installed by the Pacific Engineering Company, of Seattle, and operated by the Galbraith & Bacon Company. The machinery was built according to special designs by the Jeffrey Manufacturing Company, of Columbus, Ohio.

This departure from the old system of handling freight has enabled ships to be unloaded and reloaded more rapidly without delays from the congested traffic and blocked streets.

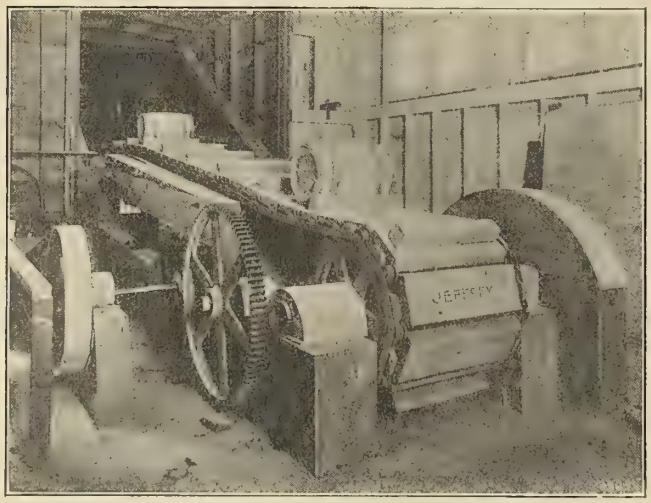


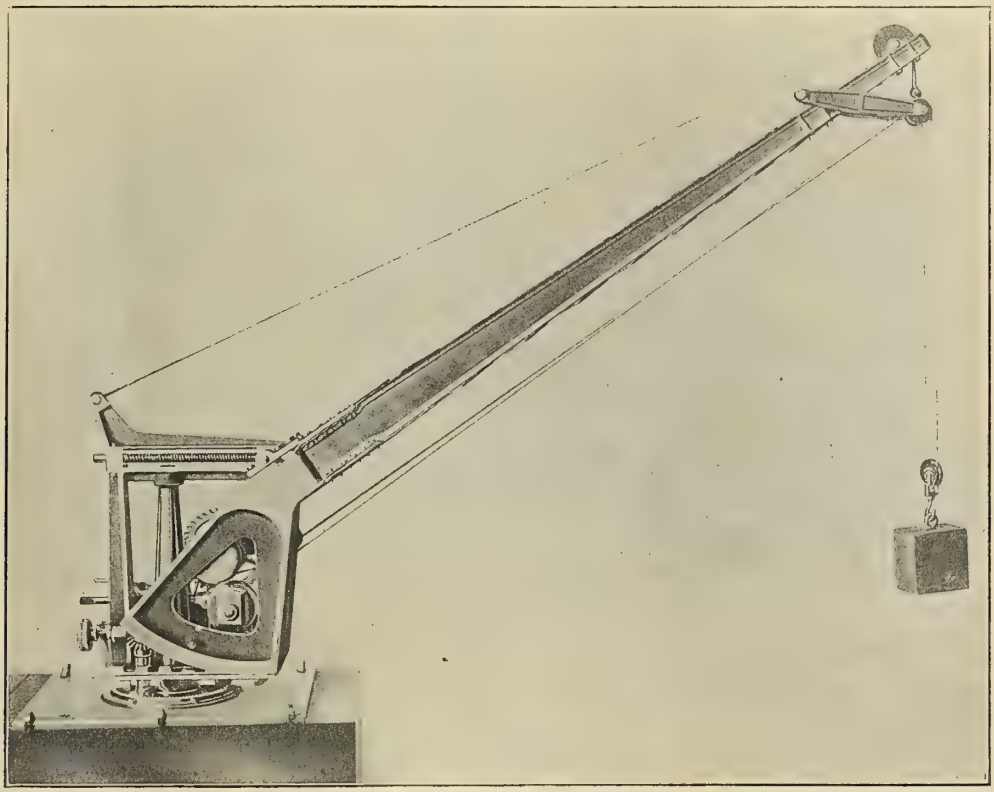
FIG. 2.—PIER END OF CONVEYOR.

FIG. 3.—WAREHOUSE END OF CONVEYOR.

That the purchase of coal on specifications needs to be followed up with analyses of the deliveries has been amusingly demonstrated by a recent incident. A certain board had for some time been buying coal on specification, but only recently did it take any steps to see whether it was actually getting the quality it was paying for. Lately it had made the first analysis of the coal delivered, and discovered that the coal was below the stipulated quality. As a result of this analysis, costing $10 (£2), the coal dealer paid a rebate of $873.01 (£174 12s.).

AN IMPROVED CRANE.

One of the simplest mechanical appliances which has been used in engineering work for many centuries is the ordinary jib crane or derrick, consisting of an upright or mast with a boom or gaff for hoisting and moving weights. Although the jib crane is universally used in engineering and industrial work as well as in factories and transportation terminals, yet practically the only features of this crane which up to this time have been improved are the methods of manipulation or the application of power for operating the crane. There have been numerous improved winches, steam and electric, but, as a rule, this part of the equipment requires separate foundations and anchorage removed from those on which the cranes or derricks themselves are mounted. It is very seldom that the motive power is located practically on the same level and within the area occupied by the derrick or crane itself. As a result of experience with the Welin quadrant davit, which in itself performs some of the functions of an ordinary jib crane or derrick, there has been developed by Capt. A. P. Lundin, of New York, and Axel Welin, of London, a quadrant crane having all the advantages of a self-contained machine, in which the crane and operating devices are mounted together in such a manner that a single operator can handle the crane for hoisting and lowering the load and moving it in a horizontal plane, so that the crane will serve with rapidity and precision every cubic foot of space within its reach.



A FOUR-TON QUADRANT CRANE.

The crane is mounted on quadrants, and is moved back and forth by a screw, which, on account of the movement of the quadrants and the method of compensating the load, is subjected only to a thrust in a true axial direction, and therefore can work without undue friction. The quadrant arrangement, with its traveling fulcrum along the base of the frame, not only reduces the length of the beam but also reduces the bending moment on the beam and eases the manipulation of the load after it has been hoisted. By the compensating arrangement of the hoisting tackle a stout wire rope or chain, permanently fixed to a point on the inboard end of the frame, runs over a sheave at the top of the crane and is fixed to the top block of the tackle proper. From the illustration it is evident that this block automatically drops in relation to the top of the beam, as the latter is swung back by means of the screw. The actual reduction in the bending moment on the beam is thus reduced in a 4-ton crane from 120-foot tons to 51-foot tons, or nearly 60 percent, and therefore permits building a very much lighter crane than would otherwise be possible if the crane were operated from a fixed pivot and required the excessive power which is usually needed in topping an ordinary jib crane. To top an ordinary jib crane with its maximum load requires approximately 50 to 100 percent more power than is necessary in hoisting the load itself, whereas in the quadrant crane the combination of moving fulcrum and compensation of the falls makes it necessary to use for topping the beam only one-sixtieth of the power required for hoisting the load. Of course, to hoist the load requires practically the same power as any other crane.

The crane can be operated by electricity, steam or compressed air, as the case demands. In the 4-ton crane illustrated a 35-horsepower motor would be used for hoisting the load, a 1½-horsepower motor for swinging the crane, and only a ½-horsepower motor for operating the screw which tops the crane. The horizontal swinging motion is, of course, done by the usual method used in a crane, but it has the advantage that a full, unobstructed swing of 360 degrees can be obtained.

As to the use of such a crane on board ship for handling cargo, aside from the rapidity of manipulation and precision which can be obtained with this crane, it is interesting to note how easily the movements of the weights can be controlled. That is, they can be landed exactly as desired, and all landings can be made perpendicularly, which is acknowledged to be a great saving in labor and other expenses in handling cargo on board ship. In other words, it is not necessary to drop the load each time in one and the same place in the hatch. Where this is done it requires a great number of men to remove the

load just dropped in time to make room for the next, while with the improved quadrant crane the load can be dropped at different points in the hatch, giving the handlers more time to stow away and naturally increases the speed of loading and discharging the ship.

With a portable quadrant crane of a capacity of 2½ tons and an outreach of close on to 20 feet, the entire weight, including drums, motors, etc., will barely amount to 4 tons. If this is compared with the 2½-ton electric cranes now used on board transatlantic ships, which weigh something like 8 tons each, the advantage of weight saving with the quadrant system is clearly demonstrated, not to mention the space saving, which is also considerable, particularly if the cranes are portable and can be dismantled and stowed away when not in use. On board ship the quadrant crane has the inestimable advantage of doing away with what is often a veritable forest of masts, booms and spars, necessary for expeditiously handling of cargo, coaling, etc. Considering all the winches necessary to operate this elaborate apparatus, and the many hundred feet of steam pipe necessary for conducting steam to the winches; the frequent leaks in the joints of the steam piping, which bends under the strain of the ship in a heavy sea, and has to be gone over by a whole staff of engineers before the ship arrives in port, the advantages of the self-contained quadrant crane become apparent.

If a ship is equipped with a number of quadrant cranes conveniently located for handling cargo and baggage and for coaling, not only can the total weight of the equipment be considerably decreased, as compared with the usual equipment of masts and booms and the time of loading and discharging of the ship and the consequent expense decreased, but after the loading and discharging have been done in port all of the cranes except one forward and one aft can be dismantled and placed either on deck or stowed in the hold.

Although these cranes may prove to be exceedingly useful for cargo ships in particular, and, in smaller sizes, for handling coal and baggage, etc., on passenger carriers, yet perhaps their greatest field is on land as wrecking cranes on railroads, cranes on docks and wharves, and cranes on building sites, besides cranes for steam shovels and various other plants of that kind, where the advantages of the lightweight self-contained machine are obvious. In some shipyards ordinary jib cranes are still used alongside the building berths, and frequently in such cases topping of the cranes is dispensed with on account of the large power required and the danger attending this operation. In such instances the usefulness of the cranes would be greatly augmented by utilizing the quadrant system of cranes and enabling the operator to have perfect control of the crane under all conditions. Also a light quadrant crane could be used to advantage in handling the work at heavy shipyard tools, enabling one man to have complete control of heavy plates, bars and forgings at such work as punching, shearing, rolling and machining.

HANDLING FREIGHT FROM STEAMSHIP TO DOCK BY A DOCK ELEVATOR.

THE OTIS DOCK ELEVATOR.

The dock elevator illustrated has been installed at a number of steamship docks along the Atlantic coast, one of the most recent installations being at the docks of the Metropolitan Steamship Line in Boston, where three of these machines were installed simultaneously, replacing the old form of moving platform, which has been discarded. The Otis Elevator Company, of New York, manufacturers of this device, are now installing two large machines for the Boston & Maine Railroad Company at their Mystic Wharf in Boston. The mechanical construction of the Otis dock elevator is quite simple. It consists of an endless chain provided with projecting steel lugs. This chain is supported, and slides in a lubricated steel channel located about 6 inches above the floor. The chain passes over a sprocket wheel at each end of the incline, the upper sprocket wheel being keyed to a driving shaft, which in turn is journaled under the floor. This driving shaft is in line with the hinges which support the inclined floor or "drop." These hinges are of heavy cast steel construction, provided with a large hollow forged shaft through the 4-inch diameter hole of which passes the driving shaft of the elevator. In this way the mechanism is always at the proper level, notwithstanding the different positions which the inclined platform may take. At one end of the main driving shaft is keyed a large gear wheel, which is driven by a steel pinion journaled about 1 foot above the floor line of the dock.

The pinion is carried on a countershaft, which is provided with a brake pulley. On the other end of the countershaft is a large belt pulley, from which a belt leads to a 10-horsepower electric motor contained in a housing. In this way all important mechanism is placed on the floor and can be easily looked after. At convenient position to the operation of the machine is provided a starting, stopping and reversing switch. There is also a special starting box provided, which enables the operator to change the speed of the elevator from slow to high speed. This control device is quite important, as frequently there are special truck loads of great weight to be handled, and at such times the machine is slowed down so that the men are able to handle it with facility. The operation of the dock elevator is as follows:

A man with a loaded truck walks onto the inclined hinged platform or "drop," and the axle of the truck drops in the recess between the steel lugs on the moving chain, and it is thus drawn up the incline without any manual effort on the part of the truckman. It will be seen that the truckman walks up the incline with his feet on opposite sides of the narrow partition along the top of which the chain slides. By this means there is no chance for the feet of the workman to be caught, as is the case with the moving platform which this type of machine seems to be replacing. The men are, as a matter of fact, assisted up the incline, because they lean back upon the truck handles and the truck really pushes them up. There is absolutely no possibility of the truck slipping backward, which was frequently the case with the old-fashioned moving platform. The men therefore feel a confidence in this machine which was lacking in the old-style moving platform.

This machine is almost as valuable for carrying loads down the incline as it is for carrying them up, and it works in either direction with equal facility. In the Boston & Maine installation two of these dock elevators are to be located on one platform and are to be run in opposite directions, and each machine is to be independent of the other. By this means it will be possible to carry loads in both directions simultaneously, or, if desired, the speed of unloading can be doubled by running both machines in the same direction. As there is a tidal drop at this dock of about 20 feet these machines are likely to save a large amount of time and labor in handling freight.

REVIEW OF MARINE ARTICLES IN THE ENGINEERING PRESS.

Powerful Dredge for Panama Canal.—This vessel, named *Corozal,* and built by William Simons & Company, at Renfrew, is an extremely powerful bucket hopper dredger for use on the Panama Canal. It is of twin-screw type, driven by triple-expansion engines working at 180 pounds pressure, and steam is supplied by two Scotch boilers. All auxiliary machinery is independent of main engines. Dredging gear can be operated by either propelling engine, and is arranged to give three speeds, depending on kind of material to be dealt with. Two sets of buckets are provided, one for soft clay and one for hard. The bucket ladder is a steel ladder, which, with its equipment, weighs over 240 tons. The ship has a hopper capacity for 1,200 tons. 450 words and photographs.—*The Engineer,* October 20.

Three Ferry Steamers.—Hulls built by Nüscke & Company and machinery by the Anstalt Akt.-Ges., Stettin. Length over the deck, 98.4 feet; length between perpendiculars, 80.2 feet; breadth, 35.1 feet; depth at side, 12 feet, and loaded draft, 8.9 feet. Machinery consists of compound engine 11.4, 23 by 15.7 inches, and a two-furnace single-ended Scotch boiler, working at 150 pounds pressure. There is a propeller at each end of the vessel, which turns at 210 revolutions per minute. The rudder at each end works within a well formed by double stern post. Engine is designed to indicate 280 horsepower. Although the article is not long it is accompanied by a complete set of detail drawings for hull and machinery. 1,800 words, 5 large plates and several smaller-sized drawings and two photographs.—*Schiffbau,* October.

French Battleships Jean Bart and Courbet.—The most powerful ships ever built for the French navy were launched Sept. 22 and 23. Their keels were laid about the 10th of last November, and they were launched with about one-third of their completed weight in place. When completed their principal features will be as follows: Displacement, fully loaded, 23,457 tons; length between perpendiculars, 541 feet 4 inches; breadth, 88 feet 7 inches; mean draft, fully loaded, 29 feet 1 inch; horsepower, 28,000; speed, 20 knots. The double bottom is carried up to the lower protective deck, and above this are two others, making three in all. This is the first time such a plan has been tried. The upper, main and lower protective decks are, respectively, 1.18, 1.9 and 2.76 inches thick. For the first time since 1899 the protection of the fore part of the ship has not been completely carried out. The armament consists of twelve 12-inch guns and twenty-two 5.5-inch quick-firing guns and four 47-millimeter guns and four underwater torpedo tubes. The *Courbet* is furnished with Niclausse and the *Jean Bart* with Belleville boilers. Each ship has twenty-four boilers grouped in four boiler rooms and served by three smokestacks. The normal coal capacity is 900 tons and the maximum 2,700 tons, giving a steaming radius of 8,500 miles at 10 knots, or 2,300 miles at 20 knots. The vessel is driven by two sets of Parsons turbines on four shafts, with a working pressure of 256 pounds per square inch. The engines are designed for 28,000 shaft horsepower. 2,500 words and photograph of launching of *Jean Bart.*—*The Engineer,* October 20.

H. M. S. Medina.—The Peninsular and Oriental liner chartered for the conveyance of their Majesties the King and Queen to India. For this trip accommodations have been very largely refitted, and a special crew will have charge for the voyage. The ship is 570 feet long, 62 feet 9 inches beam, and 20,000 tons loaded displacement. There are seven decks and passenger accommodation for 450 first class, 220 second class, besides a crew of 160. The machinery consists of two quadruple expansion engines, 30½, 44, 63, 89 by 54 inches stroke. Steam is furnished by four double-ended and four single-end boilers, working at 215 pounds pressure. 550 words.—*Engineering,* October 27.

Italian Dreadnought Conte di Cavour.—This is Italy's second dreadnought, and has the distinction of mounting the most numerous all-big-gun battery yet put into a modern warship. The main battery consists of thirteen 12-inch guns, six of which are mounted three in a turret, forward and aft. All can be trained abeam and five ahead and astern. Secondary battery consists of eighteen 4.7-inch guns placed on the broadsides and fourteen 14-pounders. Designed displacement of the ship is 21,500 tons, and speed 22.5 knots. Steam is to be supplied by watertube boilers to turbines. Further details of machinery are lacking. Article is accompanied by photographs of ship before launching and as she will appear at sea, and sketch showing general arrangement of armament, also a table comparing this with other recent dreadnoughts of the other nations. 1,300 words.—*The Marine Engineer and Naval Architect,* October.

A Steam Launch.—Messrs. Simpson, Strickland & Company, of Dartmouth, specialists in the building of high-class steam launches, have recently turned out a boat embodying somewhat unusual features. Of 42 feet length over all, with 9 feet beam and 4 feet 6 inches depth, and carvel built of mahogany, the boat possesses a degree of comfort and seaworthiness unusual in so small a craft. Propelling machinery consists of a triple-expansion engine, 4¼, 6¾, 10 by 5 inches, which, running at 600 revolutions per minute, with 250 pounds boiler pressure, indicates 62 horsepower, and drives the boat 12 miles per hour. Besides photograph of the boat article contains drawings of boiler and engine. 900 words.—*The Engineer,* October 20.

Kaiser Franz Josef I.—On Sept. 9 this vessel, the largest liner constructed in Austria, was launched from the shipyard of Messrs. Cosulich Bros. at Monfalcone. The ship is 500 feet long, of 62 feet breadth, and 42 feet 9 inches depth to shelter deck, and is expected to attain a speed of 19 knots. Displacement 16,500 tons at 26 feet draft, gross registered tonnage 12,500 tons, and deadweight carrying capacity 7,500 tons. Passenger accommodations are provided for 160 first class, 480 second class and 1,400 third class. Propelling machinery was designed and constructed by Messrs. David Rowan & Company, of Glasgow, and consists of twin-screw quadruple expansion engines, balanced on the Yarrow-Schlick-Tweedy system, capable of indicating 13,000 horsepower. Steam is supplied by six double-ended and one single-ended boiler fitted with Howden forced draft. The auxiliary machinery throughout is of the best. The vessel has been built to Lloyd's highest class. 940 words and photograph of vessel after launching.—*The Marine Engineer and Naval Architect,* October.

Marine Engineering.

Jet Propulsion.—An editorial discussion of this subject which presents some facts little thought on, which, taken by themselves, would indicate a higher efficiency to be possible than is actually obtained in practice. The other side of the question is treated later, and effectually sets aside the too sanguine hopes of jet propulsion enthusiasts. For while it is unquestioned that the jet itself is higher in efficiency than any screw propeller, yet the difficulties encountered in taking into a ship the water to be used as the jet and imparting to it velocity that can be efficiently used for the propulsion of the vessel more than offset any theoretical advantages. 1,500 words.—*Engineering,* October 27.

The Progress of the Parsons Marine Turbine.—Being a review of the fourteenth annual report of the Parsons Marine Steam Turbine Company, Ltd., which gives a list of new ships just completed or building propelled by this type of machinery. Among others are mentioned the following: Warships—For France, six battleships of the *Danton* class, two larger battleships recently launched, and two other battleships recently authorized. For Germany, armored cruiser *Moltke* completed, three battleships and four cruisers ordered. United States, battleship *Utah* completed, three battleships authorized and seven destroyers now building. For Austria, Russia, Spain and Turkey, each a battleship building. For Japan, four armored cruisers now building. Merchant Ships—New Cunard steamship *Aquitania* at John Brown & Company; two new steamships for the Hamburg-American Line; new high-speed French liner *La France;* two new passenger ships for the Canadian Pacific service in British Columbia. 1,300 words.—*Engineering,* October 13.

Care in Using Liquid Fuel.—A bulletin has just been issued by the Navy Department dealing with this interesting and very important subject. Although fuel oil as supplied to ships is the residue of petroleum after distillation, and is not itself explosive, yet gases from it when mixed with air are liable to be dangerous if exposed to any flame or spark. Hence the value of these rules to all who have to do with the loading or using in any way of fuel oil. As given in this article the rules are too numerous to be given here, but are well worth looking up by those using oil fuel. 1,000 words.—*Marine Review,* October.

Measurement of Shaft Horsepower.—A resumé of the difficulties inherent in the measurement of shaft horsepower under conditions usually found in marine engineering, followed by a description of a type of torsion meter, the Denny-Edgecomb, which is said to fulfill every requirement for accurate, precise and easy reading of shaft horsepower for turbines, reciprocating steam engines or internal-combustion engines. The meters are purely mechanical in type. Connections are fitted for taking readings directly and simultaneously in engine room, chief engineer's room and captain's cabin. 3,500 words and photographs of the meter.—*The Engineer,* October 20.

Miscellaneous.

The Anschutz Gyro-Compass.—This instrument has the advantage to the navigator that it points to the true north and is unaffected by the presence of steel. It depends on the principle enunciated by Foucault that a gyrostat with only two degrees of freedom will at any point on the earth's surface except the poles tend to set itself with its axis of rotation parallel to the earth's axis. As used with a ship's compass the gyrostat is suspended beneath the compass card with its center directly in line with the north and south line. The gyrostat is electric driven and rotates about 20,000 times per minute. It is calculated that the directive force on the card is about fifteen times greater than in the case of a good liquid compass. 400 words.—*The Steamship,* October.

First Principles of Navy Yard Management.—By Assistant Naval Constructor Richard D. Gatewood, U. S. N. A comparison of staff and line organization as applied to industrial plants, navy yards in particular. Shows the weakness of the strictly military type discipline in the construction and repair of government ships. 2,500 words.—*The Marine Review,* October.

Automatic Coaling of Ships.—At Holyhead there has been in service for about a year a coaling barge that has attracted considerable attention. Of about 154 feet over all and 27 feet breadth, the structure of the barge is divided into eighteen coal bins, nine on each side of a longitudinal well which extends the length of the boat given up to cargo. In this well are carried and operated two elevators, which hoist coal from the bins into chutes which lead to the vessel to be coaled. The elevators are operated by the upper drum, driven by gears from a double-cylinder, direct-acting engine. The barge is propelled by twin-screws driven by two sets of compound engines, 6¼, 12½ by 8½ inches, working at 90 pounds pressure. The elevators are moved forward or aft by a chain lead driven by a donkey engine in the stern. Steam is furnished by a Blake patent vertical cylindrical boiler. It is placed in the stern and steam is conveyed by flexible tubing. The system is one which admits of much flexibility, both in design of the barges and in the actual operation. The number, size and arrangement of the bins and elevators may be made to suit conditions, while propelling machinery may be made anything convenient. In actual work the elevators may be moved or the position of the barge changed while the coal already loaded is stowed and trimmed. Chutes may be turned to get a good radius of action. Elevating mechanism is said to operate economically. The barge can coal a ship at the rate of 300 tons per hour. Sketches showing general arrangements and 'midship section, together with photograph of barge in operation, given with description. 1,000 words.—*The Engineer,* Sept. 29.

NINETEENTH ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The nineteenth annual meeting of the American Society of Naval Architects and Marine Engineers was held Nov. 16 and 17 at the Engineering Societies building, New York. The meetings were opened by a very interesting address on current progress in shipbuilding and marine engineering by Mr. Stevenson Taylor, president of the society. Following this the report of the secretary-treasurer was read, showing an increase in membership of seventeen during the year, fifty-one new members were elected, eight deaths occurred, and twenty-one resignations and five suspensions were recorded. The financial condition of the society was very satisfactory. The resignation of Capt. W. J. Baxter as secretary-treasurer on account of ill health was sincerely regretted by every member of the society. To fill his place the society elected Mr. D. H. Cox, a selection which was unanimously approved. Seventeen papers were read and discussed, abstracts of which follow:

No. 1—On the Maximum Dimensions of Ships.

BY SIR WILLIAM H. WHITE, K. C. B., F. R. S., D. SC., LL. D., D. ENG.

ABSTRACT.

The subject has an interest for naval architects, shipowners, dock and harbor authorities, travelers and all classes of engineers. What seem to be chiefly needed are reasoned replies to certain questions: 1. Is it probable that the dimensions of ships will continue to grow at the rapid rate which has prevailed in recent years? 2. Will an upper limit to the sizes of ships be reached? 3. What considerations, if any, are likely to determine such a limit, for either merchant ships or warships? Probably the most useful procedure will be to make a detailed statement of facts and principles which will, for the most part, command general assent; and in doing so it may not be out of place for me to state my own conclusions on points of controversy:

I. It will be agreed that the law of growth in dimensions has operated hitherto on all classes of ships, and that its action has on the whole been beneficial. Members of this society treat as axiomatic the statement that economy in propulsion and over-sea transport has been, and always will be, promoted by increased dimensions. Stronger materials of construction have been made available; more efficient types of machinery and propellers have been devised; higher steam pressures have led to greater fuel economy, and higher rates of revolution have favored relatively lighter propelling apparatus. But after each such improvement has been introduced and utilized, the law of growth in dimensions has inevitably reasserted its claims on naval architects, and been again brought into operation in order to secure still further advantage in respect of speed, carrying power, or other features of ship design. Successive vessels belonging to each and every class have been made larger than their predecessors.

II. It must be noted, however, that—notwithstanding the remarkable developments of the last ten years—the number of ships of extremely large dimensions is relatively few. Whatever may be the future growth in size of the largest ships built for special services, the bulk of the maritime business of the world will always be done by ships of relatively moderate dimensions, and they will continue to be the largest contributors to the revenues of port and harbor authorities.

III. Naval architects will agree that, provided the money is forthcoming for building still larger ships, their construction will be possible; and that considerably increased dimensions will present no serious difficulty even if the materials for shipbuilding already available were not improved upon. The margin of possibility indeed appears to go far beyond any probable demand.

IV. Existing physical conditions in the seaports, harbors and docks of the world, necessarily impose limits on the draft of water of ships. Much has been done, at great cost, to improve accommodation and to provide increased depths of water; but it is well recognized that the increase in dimensions of ships above described has been chiefly in lengths, breadths and molded depths; the increase in drafts of water when fully laden has been relatively small. The earning powers of ships are thus lessened, and in these circumstances it is natural that a demand should have arisen, and should still continue, for greater depths of water and better accommodation for ships of the largest size.

V. Up to the present time the response made to the appeal from shipowners for increased accommodation for larger ships by authorities of the great seaports of the world has been neither niggardly nor unsatisfactory. Extensive and costly works are in progress which will provide accommodation for the largest ships now building, and leave some margin for further developments.

VI. The marvelous growth of the world's commerce in modern times has enabled these great engineering works to be undertaken hitherto under conditions which have, in most cases, either yielded fair returns to investors in dock and harbor securities, or which have been considered by governments beneficial to the whole nation and worthy of adoption irrespective of the return upon capital expenditure. The growth of traffic in most of the great seaports has also enabled earlier docks to be fully utilized by vessels of smaller dimensions than those for which the latest docks have been constructed. But while this has hitherto happened it seems not improbable that a point may be reached beyond which dock and harbor authorities will not care to go into expenditure in order to meet further increase in dimensions and drafts in a relatively small number of the largest ships; and it is well understood that this consideration particularly applies to increase in draft of water, since the cost of dredging grows rapidly with increase of depth.

VII. A brief summary of facts relating to the dimensions of locks and dock entrances recently constructed or now in process of construction is given as indicating the outcome of inquiries set afoot by responsible authorities in regard to the provision of suitable accommodation for the largest ships likely to be built.

VIII. When the particulars for locks, docks and approach channels are considered in the light of dimensions of ships it will be seen that the margins provided in most of the recent engineering works are not very great in regard to length and breadth, although they are expected to prove sufficient for many years to come, because of commercial considerations.

IX. It is a fact worth noting that ships of the maximum dimensions now built or building are not easily accommodated or moved in the largest docks and harbors. The vessels are wonderfully handy, but they necessarily require large spaces for their maneuvers, because they are so long and heavy, and in the busy waters of their terminal ports caution is required. Even in the terminal ports of the transatlantic steamers difficulties are necessarily experienced, and although they have been overcome so far they must be accentuated by any further increase of size.

X. For cargo steamers and warships no such fixed conditions or terminal ports exist. The former class are built to seek cargoes everywhere and to deliver them wherever desired. Consequently experience has led to the adoption of relatively moderate dimensions and draft of water, in order that their possible field of operations may be extended widely. Moderate draft of water is an important feature of warship design; and the tendency in recent years to a considerable increase in the deep load-drafts of warships is, from this point of view, objectionable. For warships as well as for

merchant ships expenditure on ships and armaments must be considered concurrently with that on harbors and docks.

XI. Enlarged dimensions, of course, enable certain advantages to be obtained outside the fundamental gains of economy in sea transport or increased speed, such as maintenance of speed at sea in rough weather and increased uniformity of service between terminal ports; greater steadiness and good behavior in rough water and increased comfort for passengers; better and more spacious accommodation for larger numbers of passengers; the attraction which many passengers have toward the "biggest ships afloat." Further increase in the dimensions of ships will have little or no effect upon regularity of performance of service between terminal ports, and large dimensions are not necessary to secure moderate rolling and easy motion.

XII. It would appear that the main determining factor in regard to maximum dimensions for future mercantile vessels must be found on the commercial side and not on the technical. If ships cannot be made to pay dividends on the capital sums invested in them—after meeting working expenses and cost of up-keep, and making due allowance for insurance and depreciation—they are not likely to be built.

XIII. For warships other considerations than those of first cost and cost of maintenance must determine the maximum dimensions which should be adopted. As outlined by Sir William in a paper before the society last year his conclusion, based upon long-continued study of the problem, is that the wiser course in warship building would be found in a return to more moderate dimensions and a reduced unit cost for capital ships.

No. 2—Dock Facilities in New York City—Present Facilities, Proposed Improvements and Enlargements.

BY WILLIAM J. BARNEY.

ABSTRACT.

Attention is called to four broad divisions of freight handled in the port of New York as aids in considering the present facilities, their disadvantages and the proposed improvements and extensions: First, "trans-shipments," which include the freight that enters and leaves New York merely as a port of entry for trans-shipment on its way between foreign countries and other parts of our own country; second, "city imports," comprising the foreign freight coming into the port of New York for direct consumption in the city of New York, especially on the Island of Manhattan for retail distribution therefrom; third, "passengers," preferably to be landed in Manhattan because of the hotels, theaters, shops and railroad stations, and, fourth, "railroad city" traffic, or goods from the hinterland, for consumption in the boroughs of New York, and their own exports thereto, which must of necessity pass over the bulkheads and piers of these island boroughs. The logical plan for handling these four classes of freight would be to reserve the water front and the immediately adjacent upland for the maritime commerce; that is, for the "trans-shipments," "city imports" and "passengers"; on the other hand, to receive the "railroad city" freight and supplies for the city at depots and freight yards so far removed from the water front as not to curtail the maritime development and the cheap handling of maritime freight. For handling "trans-shipments," and also for "city imports," there is to-day one great terminal in New York developed and managed by private interests, and two other freight terminals of importance. Aside from these terminals little has been done in an organized manner for "trans-shipments," but the port authorities have in view the installation by the municipality of terminals for "trans-shipments" and "city imports" in South Brooklyn, on the east shore of Staten Island and at Jamaica Bay.

In connection with this presentation of the present water front freight terminals in the harbor and their proposed extensions, the present lack of mechanical equipment is worthy of note. Practically no piers in New York harbor, aside from the "Chelsea Piers," are equipped with cranes and other mechanical freight-handling devices.

On the North River, the upper sections of Manhattan, where developed and not occupied by parkways, are at present largely occupied by river lines, small crafts and barges handling building materials and coarse freight. The lower Manhattan water front on the North River is a natural location for the large passenger and packet express steamers, since their passengers and cargoes are destined particularly for Manhattan. There is one large transatlantic passenger and packet freight installation in the port of New York—the Chelsea Section, between Twelfth street and Twenty-third street. Of ninety-five piers on the North River below Sixtieth street, forty-one piers, or nearly one-half, are occupied by the railroad companies or the "city railroad" freight. Excepting the New York Central, the great trans-continental railroads reaching this port terminate on the Jersey shore, and the freight cars are carried on car floats over from the Jersey side to the various piers of the different railroads in Manhattan. This method of handling the "railroad-to-the-city" freight results in a floating freight yard from the Battery north to Twenty-third street, a part of the water front which is imperatively required by the growing maritime interests in the port. Therefore, to provide properly for the steamship lines and yet to conserve the railroad facilities of the city, freight cars must be given a common point of entry to the city upland in a less congested district of Manhattan with track connections into the downtown wholesale and business districts. It is therefore proposed to install a series of car float transfer bridges between Thirtieth and Fortieth streets on the North River, and there to concentrate the delivery of all car floats now occupying the water front in lower Manhattan, and by means of ramps or inclined planes to bring these cars from these car floats up onto an elevated railroad to run south from Twenty-fifth street along the marginal way. It is further proposed, by means of elevated sidings from this elevated railroad, to place these cars into the second story of large freight terminals or warehouses, etc., on the east or inshore side of West street. The freight is there to be unloaded onto receiving platforms either by storage or for delivery at the street level to trucks, etc., by chutes, elevators, or other mechanical devices. The reverse procedure will handle outbound shipments. By practically doubling the maritime capacity of the central part of New York harbor it is believed by the department that such an installation and reorganization of the port facilities will more than handle the prospective growth of maritime commerce for many years to come, and also meet and solve the difficulties presented by the increasing length of transatlantic steamers.

No. 3—Some Model Basin Investigations of the Influence of Form of Ships upon their Resistance.

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

ABSTRACT.

In a paper three years ago before the society upon the influence of the shape of the 'midship section upon resistance I showed that within the range of a limited number of experiments the influence of the shape of the 'midship section upon resistance, while appreciable, was not great, and for the variations practicable in a given case would usually be almost negligible. The present paper gives the results of some experimental investigations of the effect of shape toward the extremities. The field is a very broad one, and the experi-

ments are far from completion. The results now given, however, are complete in themselves, and it is believed throw a light on the portion of the field they cover. Two series of models, namely, Series Nos. 29 and 32, were used. The displacement in fresh water was in every case 2,250 pounds, and the length of each model 20 feet. The 'midship section coefficient was in each case 0.96 and the ratio of beam to draft 2.5. The longitudinal coefficient of Series No. 29 was 0.60, and Series No. 32, 0.64. Hence the beam and draft in Series No. 32 were slightly less than in Series No. 29. It will be observed that each series consists of sixteen models. This resulted from the fact that in each case four different curves of sectional area were used and four different waterlines. The waterlines were largely the same for the two series. Each curve of sectional area being combined with each waterline resulted in sixteen models. In addition the models of each series, which all had the same 'midship section, were made in halves, so that each bow could be combined with each stern, resulting in 256 possible combinations for each series. As will be explained later there were a number of different combinations made during the experiments, but not 256. For convenience and simplicity the stern profiles are rectangular. The bow profiles are practically rectangular. The curves, of sectional area, have a value at the bow, or, in other words, the bow below water is of a simple bulbous form. In each case half of the displacement was forward of the center and half of the displacement abaft of the center. The waterline, however, had a greater area abaft the center; the coefficient of the after half of the waterline of Series No. 29 being always five points greater than that of the forward half of the waterline. In each case of Series No. 32 the after waterline coefficient was ten points larger than the forward waterline coefficient. This was done to make the waterlines approach more closely average practice.

The resistance being due partly to the surface and partly to the disturbance created, the first question to be investigated is the relative surfaces of the various models. It is found that the variation of wetted surface is not great. Bearing this in mind we may safely say that the effect of practicable variations of shape of sectional area curves and waterline fineness upon wetted surface are comparatively small. Fine ended curves of sectional area result in somewhat greater wetted surface, but the difference is not more than 2 percent or so for very great variations of sectional area.

Let us take up now the experimental results. Bearing in mind that comparatively few vessels are driven at speeds greatly above that corresponding to 4 knots for the 20-foot model, it is found that the variation of resistance corresponding to very radical variations of form of the three models in each case are after all not great. It is interesting to note the critical speed, a little above 4 knots, at which the models change place materially. Models which are of the extreme type, combining full ended sectional areas and fine ended waterlines, are the worst below 4 knots, while between 4 and 5 knots they show themselves the best. This is a typical result and shows that the features of a model should be adapted to suit the speed.

Taking up now the question of residuary resistance rather than the total resistance, a study of the results shows the tendency to straighten out or change relative positions beginning, roughly, at or a little below the speed length ratio of 0.9, corresponding closely to a 4-knot speed for a 20-foot model.

For Series No. 29, where the longitudinal coefficient was 0.60, in every case the fine bow appears to be the best at low speeds. Moreover, the fine bow in combination with the full stern appears better than the fine bow in combination with the fine stern. At higher speeds the fine bow with the full stern loses its superiority. Considering Series 32 (longitudinal coefficient 0.64), while the fine bow appears to be a little the best at low speeds, it does not show as much superiority as it does for the Series No. 29, and at the higher speeds, too, the fine bow is relatively worse. Broadly speaking, the fine ended curves of sectional area have the better of it at and below a speed length ratio of about 0.9, while at the high speeds they are the worst in every case. It was difficult to separate the effect of the bow from the stern. Undoubtedly the resistance of a given stern will be different as it is combined with varying bows, and vice versa. It was not practicable to test all bows with all sterns, as this would involve testing 256 models for each series. Some investigation was made, however, of the stern effect by combining a single bow with all sixteen sterns in each case. The common bow used was one where a rather full waterline was combined with a rather fine ended type sectional area curve. The results where the curves are grouped by waterlines show remarkably small variation for all speeds, indicating that we may materially vary shape of curves of sectional area aft without material effect upon resistance. With the same curves grouped by curves of sectional area for moderate speeds these again show comparatively small variations, but at high speeds the variations, while not great, are appreciable, and the results unwelcome. W. Froude many years ago laid down the dictum that, broadly speaking, the U-bow and V-stern were favorable to speed. Now the fuller the waterline aft and the finer ended the curve of sectional area the more the stern approaches the V-type. The first group of curves indicate clearly that for usual speeds the V-type of stern is superior, but the second group shows at about a speed length coefficient of 0.95 a change in relative positions of the curves, and in every case the fine waterline aft is the best at high speeds. Careful consideration of these results will, it is believed, warrant the conclusion that the primary factor involved here is waterline fineness, the variations with changes in curves of sectional area being subsidiary. There is not much to choose between the sterns with fine ended and full ended curves of sectional area. Of course, in practice we would wish to use with a fine waterline aft a fine ended curve of sectional area to avoid a bulbous stern.

There remain two questions to be considered, namely, what is the best combination of coefficients in the case of each series, and how much can we affect the resistance by adopting this best combination? For the minimum resistance at the high speeds we need to materially fine the ship at the waterline and fill it out below water. The broad conclusion to be drawn from the results I have obtained are confirmed by other experiments which agree in indicating that the type of form suitable for low and moderate speed length ratio below 0.9 is not at all adapted for high-speed length ratios of 1 and above. The reason is, I think, to be sought in the relative dimensions of the ships and the waves which it makes. At the low speeds only the ends of the ship, and more particularly the forward end, materially affect the resulting waves, which, after all, are small and offer but comparatively small resistance. At the high speeds, however, the whole fore-body has to do with the creation of the waves, and we decrease resistance by making the waterline as fine as possible and putting as much as possible of the displacement well below water, where the pressures, due to its thrusting itself into the undisturbed water, will be as much as possible absorbed in doing the necessary pumping aft of the water and not in raising the surface into waves.

It will be found upon studying the contours and lines that while for medium speed work lines of the U-type are excellent, there is material decrease in resistance for high speeds by approaching the type of the bulbous bow. It is true that the latter models indicate also a bulbous stern, but we have found that the main factor here is the fine waterline aft for high speed, and not the full ended curve of sectional areas. As pointed out already the models of Series Nos. 29 and 32 are

not of high-speed type, and I would not feel warranted in drawing any conclusions from them as to high-speed work did not results so far from high-speed models appear to agree with those from Series Nos. 29 and 32. I think, then, there is little doubt that for high-speed work up in the region where $\frac{V}{\sqrt{L}}$ is from 1 to 1.2, the bulbous type of bow is distinctly superior as regards resistance. While there are some practical objections to it, they do not seem to be very serious, and I see no reason why in many cases some approach to the bulbous type could not be made to advantage. The extreme U-type of bow, where the fore foot is carried as far forward as possible and the sides are practically vertical, the waterline being made as fine as possible, is the nearest approach to the bulbous type of bow that can be made without departing from conventional ideas, and where adopted this type of bow will give less resistance for high-speed work than bows of less pronounced U or V-type.

No. 4—The Resistance of Some Merchant Ship Types in Shallow Water.

BY PROFESSOR HERBERT C. SADLER.

ABSTRACT.

During the past two years a number of models of various merchant ship types have been tested in water of varying depth in the "tank" at the University of Michigan. The characteristics of each form are given in the paper with the curves. They range from fine to full types. Some of the broader types of from five to six beams to the length and one with V-shaped sections have also been added. In each case the curves represent the residuary resistance in pounds per ton of displacement. The false bottom was fixed at definite depths, and all models were tested at these depths of water. As many of the models represented actual vessels, and were not of the same length, they were loaded in each case to their respective load-drafts, hence the depth-length or depth-draft ratio varied in most cases.

In connection with the above it may be of interest to note that various "humps" in the resistance curves occurred at practically the same speed irrespective of the length of the model, which indicates that the speed at which the maximum resistance occurs is a function of depth of water rather than size of ship.

Cross curves representing the variation of resistance in terms of depth of water are given on each diagram; also curves showing the approximate speed-length ratio at which the residuary resistance begins to increase as compared with deep water.

Results were obtained for a typical set of merchant ship forms varying in prismatic coefficient from about 0.5 to 0.85, where the first "hump" in the curve for a given depth occurs at nearly the same speed for all types. There is, however, a tendency for the maximum to occur at a higher speed as the form of the vessel becomes finer.

With curves for two vessels of the same dimensions and practically the same prismatic coefficient or curve of sectional areas, but differing only in area of 'midship section, and hence block coefficient, the curves of residuary resistance per ton of displacement in shallow water have the same characteristics as those of deep water; but as the humps occur at earlier speeds and are much more pronounced in the shallow water, the form with the finer 'midship section appears to have an advantage over the fuller type, particularly at what may be termed the "practical" speeds for this form.

In similar sets of curves for a slightly fuller vessel than the previous one, the same general characteristics appear to hold in both cases.

Curves were obtained for a broad vessel with practically V-shaped sections throughout. In this case the vessel was tried at two drafts. The "humps" occur at the same speeds for each draft; also these are not so pronounced as in the types with fuller 'midship sections. This is probably due to the fact that the mean draft of the 'midship section is much less in this than in the previous cases.

It is often of interest to know at about what speed the first "hump" is likely to occur for a given depth of water. The speed-length ratios at which this maximum resistance may be expected have been plotted on a depth-length ratio base. In this case the total resistance of the model has been taken. Other published results have been added for comparison, and from these, which are mostly for torpedo boat destroyers and vessels of a somewhat similar type, it appears as if the "hump" for a given depth of water occurs at slightly higher speeds in the fuller forms. Observations of the wave formation at the critical speeds confirm those already given by previous writers. At or near these speeds the vessel tends to form a train of waves at the stern, which extends for some distance from each side of the ship and at right angles to the same. After passing this point the normal type of bow and stern wave gradually reappears. It is possible, therefore, with the limited dimensions of the tank, that the sides may have some influence upon the results at these speeds. As, however, the first critical speed, especially at the smaller depth-length ratios, would be practically impossible of attainment in the types given, any slight error involved does not have much weight.

No. 5—Panama Canal and American Commerce.

BY LEWIS NIXON.

ABSTRACT.

That commerce will be stimulated by the opening of the Panama Canal is generally admitted, but that its advantage will be uniform to all countries is, of course, impossible. The men who framed our Constitution and who in Congress later carried out its intentions and ideals in laws, thoroughly understood that the three pillars of national greatness and prosperity were commerce, agriculture and manufacturing. We neglect the commercial pillar, although the proportion of exports which consists of foodstuffs and staples that foreign countries must have to feed their people and their factories is falling, while the proportion of manufacturing commodities in which we have to meet the competition of the world is increasing. What this society probably wants to know is, Are there means by which the vast sum spent for the Panama Canal can be of help to the varied interests of this country instead of furnishing issues of bonds with which to aid the continuance of our present currency system, the existence of which is as much a tax upon us as is the non-existence of a merchant marine? This canal is a thoroughfare through our territory and should be free to our vessels. A rebate to our own vessels would be a cowardly compromise. Mexico, Central America, the West Indies and the northern shores of South America are at the door of the Panama Canal. As trade and transportation focus to the Isthmus, and the governments surrounding it become stable and safe fields for investment, so that their vast potential resources may contribute to the world's commerce, I look to see in a few years the Caribbean Sea and the Gulf of Mexico girdled by prosperous cities, with trade rivaling in activity and prosperity the cities of the Great Lake basin. By treaties with these countries we should extend our coasting laws to them, with the understanding that all vessels owned and operating under the flags of either party to the treaty, say on Jan. 1, 1912, shall

enjoy reciprocal liberty of commerce in the ports of either party, after that date vessels constructed in either country to have the same privilege. My earnest conviction is that we must return to our early policy of discriminating duties and tonnage taxes if we are to revive our merchant marine in the foreign trade. As to the establishment of mail lines to South American ports there are two points needing attention. We must not gage our service by comparison with existing ships running from the United States to South America, but by comparison with ships running from European ports, and the question of renewals should be carefully considered. Personally, I think thirty years the absolute minimum for such contracts. In this way, as needed, new and better vessels will be added, and the older vessels will go into the freight or the accommodation and reserve service so essential to a growing line.

No. 6—Experiments on the Froude.

BY PROFESSOR C. H. PEABODY.

ABSTRACT.

The paper describes experiments made on the resistance and propulsion of ships by the aid of navigable models made at the Institute of Technology. The prototype chosen for the investigation was the revenue cutter *Manning,* which was tested by the writer in 1899. The model was made one-fifth of the length of the *Manning,* and, although properly called a model, the craft, which was named the *Froude,* is a miniature steamer of considerable size and displacement, which handles and behaves like a ship and not at all like a steam launch. The *Froude* is indirectly propelled by a gasoline (petrol) electric generating set and an electric motor with a chain drive to the propeller shaft. Measurements of the friction of the propelling machinery were made first by aid of a friction brake attached behind the propeller when the boat was hauled up, and later by a friction brake installed within the hull, when brake tests were made with the propeller removed but otherwise with the boat under service conditions. The experiments with the *Froude* consisted in making a series of progressive speed trials over a measured course, usually an eighth of a knot long. A continuous recording device was installed for recording the data from the progressive speed trials. A model of the *Manning* was also made and tested in the model basin at Washington for results to be compared with the progressive speed trials of the *Manning* itself and also of the *Froude.* A propeller for the *Froude,* planed according to the working drawing of the *Manning's* propeller, was installed after being tested at the model basin. These investigations were carried on in 1910 and 1911. The work in 1910 was to install, adjust and rate the machinery and instruments and learn the limitations of the experiments, and also to make tests with the propeller. Tests were made with the propeller hub successively 3, 6, 18 and 30 inches abaft the stern post. The comparison of the thrust and power curves obtained showed that the location of the propeller with regard to the stern of the boat and the broad stern post had a large effect on thrust and power required to drive the boat. The results led to the conclusion that a large waste of power is due to setting the propeller in the eddy astern of the rudder post, and that when the propeller is once free from that eddy there is only the normal and regular gain that may be expected from carrying the propeller well away from the stern.

Considering all the elements that entered into these investigations, the author feels justified in claiming an error of precision of 1 percent for results of tests at full power and speed; at slower speeds and smaller powers the errors are liable to be larger, perhaps as much as 2 percent. There are certain anomalies, especially at low powers and speeds, for which no explanation is offered. They are too well marked to be attributed to errors or uncertainties on observation or reduction. Among these are the curious variations of wake, and especially the indication of negative thrust deductions. To the author's mind it appears possible that the degree of precision of the work may be sufficient to reveal real anomalies in the accepted convention concerning the intersection of hull and propeller. He considers the most noticeable feature to be the small wake computed for the normal setting of the propeller 1 inch from the stern post, more especially as the wake for the 3-inch setting while the propeller is still affected by the eddy behind the stern post is what may be reasonably expected. The gain in propulsive efficiency for the latter setting, as indicated by a comparison of the shaft horsepowers, is only 3 percent.

One of the most interesting and important results of these investigations is the comparison with the progressive speed trials of the *Manning* reported by the writer to this society. The question of direct interest to the shipbuilder and the naval architect is the power which should be given to a certain ship to give a desired speed. As a contribution to the answering of this question the comparison was made of the actual observed power of the *Manning* with an estimation of power from the resistance of the 23.5-foot model, as determined in the model basin, together with an estimate of the wake and the thrust deduction from the tests of the *Froude.* He shows that an estimate of the power for the *Manning* from the 23.5-foot model would be in excess, apparently, 15½ percent. This discrepancy is considered by the author as normal instead of exceptional, since, in the case in hand, the speed length ratio is 1.17, which indicates an abnormally high speed for a ship of the type of the *Manning,* and the power probably increases as the fourth power of the speed, if not more rapidly, instead of the cube of the speed, as the power of a ship is commonly assumed to vary. If the fourth power be taken in this case then an over-estimate of 16 percent in the power would give only 4 percent excess in speed. The author enumerates several elements which enter into an analysis of this discrepancy, and concludes that an estimate could be made of the influence of each element which would be plausible, if not probable, in such a way that the entire discrepancy could be explained away if necessary.

Since the investigation in 1910 showed such an exceptional influence from the broad stern post, it was decided to fit a fair-water to give conditions more nearly like those of ordinary practice for steamships. The main object of the investigations in 1911 was the determination of the influence of the pitch and area of the propeller on propulsion. Three propellers were made, each 2 feet in diameter, with a projected area ratio of about .6 of the disk area. Three pitch ratios were chosen, one normal and the other two abnormal, one being much less and the other much greater than obtains in practice. Variations of both pitch and width of blades in these two experiments were much greater than are likely to be assigned to any given design, even by engineers who differ widely in practice; consequently the conclusion is that the practical efficiency of well-designed propellers is very little affected by ordinary variations of pitch and width of blades. To this conclusion may be added that all propellers having ovoid forms of blades are sensibly equal in efficiency.

No. 7—The Effect of Waves upon a Taffrail Log.

BY PROFESSOR HAROLD A. EVERETT.

ABSTRACT.

The causes of the erratic behavior of taffrail logs have been variously ascribed to poor mechanical construction, wake and torsional elasticity of the log line. Some years ago the Institute purchased a log intended to eliminate the first and last sources of error, and in order to do away with the second it

was proposed to tow this log from a long spar projecting from the side of the ship. The results of those trials showed such an erratic behavior of the log constant that it led the author to suspect that another source of trouble than any of those previously mentioned was the real cause, namely, the effect of the waves which the ship carries along with herself. Considering only the stern wave system we should expect to find a log which was towed behind a ship alternately over-running and under-running as the ship gradually increased in speed. These variations would correspond to the successive traveling of hollow and crest past the log as the transverse waves behind the ship gradually lengthened with the increasing speed. As the ship is propelled through the water at gradually increasing speed the bow-wave system when it reaches the stern alternately increases and decreases the height of the transverse waves of the resultant stern system. If the bow waves were of equal height to the stern waves at the time of their reaching the stern system, the resultant waves would be twice as high as the individual waves when the two systems came crest to crest, and would be nil when they came crest to hollow. The speeds of the ship at which these two events occur can be figured with reasonable exactness. They, of course, correspond to the speeds of maximum and minimum wave interference, and the theoretical conception of these speeds has been verified by experimental work in towing basins and elsewhere. The author shows how to construct a curve showing the variations of the log factor due to this effect of the waves upon a log towed at a constant distance from the ship during progressive speed trials, taking into account the calibration curve for a log towed in still water. On progressive speed trials of two steamships a recording log was towed, obtaining the ratios of the speed curve to the log curve, and these ratios were plotted on the speeds of the ship as abscissæ. Superimposing this plot upon the curve for variation of the log factor for successive speeds, it was found that the points determined coincided with the curve of log factor variations, thus bearing out the author's theory of the effect of waves upon the log. The results of these trials show definitely: (1) That any taffrail log is seriously affected by the wave system carried along by the ship. (2) That in order to be available for measurement of distances at different speeds it must be calibrated by obtaining many points at closely adjacent speeds and in some manner that takes account of the wave action. (3) The length of the log line must be unchanged throughout calibration and subsequent running; and (4) that a taffrail log as a close measurer of speeds is a questionable instrument.

No. 8—The Raising of the Drydock Dewey.

BY NAVAL CONSTRUCTOR L. S. ADAMS, U. S. N.

ABSTRACT.

The drydock *Dewey* sank at Olongapo, Subic Bay, Philippine Islands, May, 1910. The cause for the sinking was at the time unknown, and three methods were proposed for attempting to raise the dock. The author gives a detailed description of the dock and its position after sinking, and then describes the work carried out in raising the dock. All three methods were tried. The first two failed and had to be abandoned, while the third was carried out successfully. The first method consisted of introducing compressed air into certain of the bottom tanks on the port side, which was most deeply immersed. It was found that after installing the manhole doors and plugging all vent pipes the compressed air which was introduced leaked through the bulkheads, which proved to be non-watertight at the tops, allowing the air to pass through them from one tank to another. The second method involved clearing the compartment, which contains the forward centrifugal pump for operating the dock, of water and operating the dock's own pump by steam furnished from a tug. Clearing this compartment of water necessitated building a steel cofferdam and installing pumps. The end bulkheads of this compartment were not watertight, and were inadequately stiffened, requiring extensive shoring and calking. Due to defective stop valves the pump took water from the high tanks before removing any from the low tanks. Considerable progress was made in this direction, but after some time it was found that the dock's own pump was in such bad condition, due to having been working in mud and salt water and from excessive inclination, and also due to the breaking of the oiling gear, it needed overhauling. This method was then abandoned. In the third method the whole top and bottom decks and the side walls and machinery space on the sunken side were made watertight. Then by clearing this whole space of water, which would provide nearly 3,000 tons of buoyancy, and then by utilizing the dock's own pump to raise her, or by mounting pumps below, the dock could be raised. This was successfully accomplished. As soon as the dock was raised a careful examination showed that the cause of the sinking of the dock was due to the fact that the vent pipes from the tanks were badly corroded and had given way in places, thereby leaving large areas open to the sea. When the dock was up these vent pipes were always above the surface of the water, but when the dock had been lowered for docking these vent pipes were mostly under water, and the water entered them and gradually filled the ballast compartments of the dock, which caused the sinking. The work, and those who accomplished this gigantic task, deserve the highest praise and commendation.

No. 9—The Best Arrangement for Combined Reciprocating and Turbine Engines on Steamships.

BY G. W. DICKIE.

ABSTRACT.

It so happens that both types of steam engine have an economical and a wasteful end. In the turbine the steam begins its work in the wasteful end and finishes in the economical end, while in the reciprocating engine this is reversed. I believe that the best result in steam consumption could be gained from having the terminal pressure for the reciprocating part of the engine power at or about 30 pounds absolute, or a little above the usual low-pressure receiver pressure in triple-expansion engines. Notwithstanding the important advantages claimed for the arrangement of two reciprocating engines and one turbine, as used on the White Star Liners, I believe that better results, with installations up to 20,000 horsepower, can be secured by having one reciprocating engine on the center line delivering steam to a turbine on each side at about 30 pounds absolute. This would admit of the center-line engine developing about 40 percent of the total power, and, when exhausting straight to the condenser, at least 60 percent of the full power. The larger and most effective propeller would be on the center line, where its efficiency would have the best propelling effect. The smaller side propellers would not require so wide projections from the side of the ship, and would thus cause less disturbance to the water in the after run. With the large propeller in the center, the side propellers could be run at a higher number of revolutions than would be advisable for the center propeller were it turbine-driven. This would permit of the turbine rotors and casings being of a moderate diameter. In a 20,000-horsepower set of engines, with the center-line shaft making, say, 78 revolutions, I would have the side shafts running about 400 revolutions, which would give a diameter of about 8 feet to the rotor. This would enable the turbines to be placed alongside the reciprocating engine in any merchant ship having that amount

of power. With the reciprocating engine closing its work with a terminal pressure of 30 pounds absolute, a simple compound engine would give satisfactory results. The wet and dry air pumps could be operated through levers worked from the crossheads of the low-pressure cylinders, and the feed pumps independently. This arrangement admits of a cooler engine room than can be obtained where the hottest parts of the machinery are in the wings and, in most cases, under deck. In the arrangement proposed by the writer the hottest parts of the machinery are directly under the casing that leads up through all the decks to the open air above. Two objections to this arrangement should be considered, viz., the sacrifice of the maneuvering power of two propellers on reversing engines for that of one, and the loss of backing power if a breakdown should occur. In reply to this it is claimed that the advantage of a simpler and cheaper arrangement with the most effective propeller on the center line of the ship and the promise of better economy should outweigh any possible advantage for maneuvering that the twin screw has over the single-screw ship, and the possibilities of breakdowns with the simple type of reciprocating engine proposed are very remote.

No. 10—The Parsons Marine Steam Turbine and its Application to Various Classes of Vessels.

BY E. H. B. ANDERSON.

ABSTRACT.

The object of this paper is to put before the members of this society some of the various arrangements of turbine machinery in past and present vessels which are fitted with Parsons turbines. In torpedo boats and small fast steam yachts the pioneer three-shaft arrangement of machinery is still installed. In the earliest turbine destroyers four shafts were fitted. This design was followed in the next destroyers by the standard three-shaft arrangement, to which was added two cruising turbines in series, arranged at forward end of each low-pressure turbine. For small fast cruisers the three-shaft arrangement has been found very satisfactory. Among the smaller cruisers and scout cruisers the four-shaft arrangement has been adopted largely. In battleships and cruisers of the *Dreadnought* type, four shafts are fitted. In the latest ships of this type, cruising turbines have been dispensed with, and although it was recognized that the addition of cruising turbines improved the economy to a large extent, the complication, together with the fact that such turbines are often running idly, decided against installing them in ships of this type, especially where cruising turbines are fitted in parallel. The main difference in the machinery layout of American battleships compared with those of the *Dreadnought* type, is that the cruising turbines are arranged in series instead of in parallel. In the mercantile marine the three-shaft arrangement of turbine machinery similar to that installed in the first ship, the *King Edward,* is still used in almost all ships except those of very large power. In 1905 a two-shaft arrangement of machinery was installed in the steam yacht *Narcissus.* The *Lusitania* and *Mauretania* have four-shaft arrangements of turbines, which consist of two independent sets. A modified arrangement of turbines has been adopted in the French liner *France,* now nearing completion, which will further improve the economy, as the turbines are arranged in series similar to the Spanish battleships. A similar arrangement of machinery is being adopted in the new Cunard liner *Aquitania,* now under construction on the Clyde, and also for several other ships. The combination arrangement of turbines and reciprocating engines has also given good results, as instanced by the *Otaki, Laurentic* and *Olympic,* and notable other installations are now being made.

The first application of a geared turbine was made by the Parsons Marine Steam Turbine Company in 1897, and later, in 1910, the steamship *Vespasian* was fitted with a geared installation of turbines. At the present time two fast destroyers are nearing completion in England having geared turbine machinery driving two shafts. Two Channel steamers for the London & South Western Railway Company are also under construction. With regard to the question of multiple shafts, the present tendency among certain naval authorities is to cut down the number of shafts and turbines in vessels of the destroyer classes. A difference of opinion appears to exist as to whether two, three or four shafts are most suitable from an economical and a practical point of view. The arrangements of the engine-room bulkheads and the sub-division of the machinery space are also discussed.

As regards the steam consumption of turbine machinery, in the *Turbinia* the measurements figure out giving a water rate of about 15 pounds per horsepower, all purposes at full power. In H. M. S. *Amethyst* the water rate in pounds per horsepower for all purposes at full power averaged 13.60 pounds. This agrees very closely with a figure of 14.0 pounds per shaft-horsepower which was obtained with United States destroyers. In battleships of the *Dreadnought* type the water consumption in terms of shaft-horsepower of main engines averages about 13.0 pounds for turbines only. In large cruisers of the *Indomitable* type the consumption for turbines only averages about 12.0 pounds per shaft-horsepower. In ships of the mercantile marine the steam consumption of the turbine machinery for all purposes in terms of shaft-horsepower of main engines averages about 15 pounds, and in large installations, such as the *Mauretania,* about 14 pounds. In vessels fitted with a combination system of reciprocating engines and low-pressure turbines, a saving in coal consumption of about 12 percent is made, compared with similar ships having quadruple-expansion reciprocating engines only. In a battleship or cruiser installation an arrangement of geared cruising turbines would effect a saving of at least 20 percent at a cruising speed of 12 knots, this comparison being made with an installation having direct-coupled cruising turbines. A further increase in economy can be obtained by increasing the coefficients of the turbines. This would improve the results without any increase of machinery weight, due to a saving in the boiler-room installation. A further economy of steam consumption is realized by arranging to pass all available auxiliary exhaust steam at suitable stages into the turbines instead of passing this direct to the main condensers.

In 1905 the total amount of Parsons turbine machinery of the marine type completed amounted to about 270,000 horsepower. At the present time the total horsepower completed and under construction amounts to approximately 6,400,000, of which about 5,300,000 is to be fitted in warships; of this total 1,900,000 horsepower has been ordered during this year. In the German naval programme of this year a total shaft-horsepower amounting to 281,000 is being installed in ships fitted with Parsons turbine machinery, being 58 percent of the total ordered this year.

Papers 11=17.

The other papers read and discussed at the meeting were: "Ship Calculations, Derivation and Analysis of Methods," by Naval Constructor T. G. Roberts, U. S. N.; "Economy of the Use of Oil as Fuel for Harbor Vessels," by Engineer-in-Chief C. A. McAllister; "The Marine Terminal of the Grand Trunk Pacific Railway, Prince Rupert, British Columbia," by Frank E. Kirby and William T. Donnelly; "Cargo Transference at Steamship Terminals," by H. McL. Harding; "Heavy Oil Engines for Marine Propulsion," by G. C. Davison; "Automatic Record of Propeller Action in an Electrically-Propelled Vessel," by W. L. R. Emmet; and "Some Applications of the Principles of Naval Architecture to Aeronautics," by Naval Constructor William McEntee, U. S. N. Abstracts of these articles will appear in the January issue.

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Naval Architects' Meeting.

After the period of depression which has existed during the last few years in the shipbuilding industry it is gratifying to note the progress which has been made in naval architecture and marine engineering and in the improvement of terminals and harbors to meet the rapidly increasing demands of present conditions for a larger and more efficient merchant marine and a stronger naval power. At the nineteenth annual meeting of the Society of Naval Architects and Marine Engineers recently held in New York papers were presented containing some valuable investigations regarding the resistance of ships, discussions of the recent remarkable developments in propelling machinery, and descriptions of modern methods of handling freight at steamship terminals and proposed improvements in existing terminals to promote maritime commerce. These subjects formed the basis of one of the most interesting and instructive meetings that the society has ever held.

Three papers were read dealing with various problems regarding the resistance of ships. They presented the results obtained from towing models in basins at the Government station in Washington and at the University of Michigan, and also from progressive speed trials of a navigable model at the Massachusetts Institute of Technology. Investigations in such a field, where current practice in the design of vessels varying widely in form and conditions of service depends largely upon speculation and deduction from theory and practice without definite information as to the actual effect of various factors influencing the resistance, are of inestimable value, and the presentation of the results of these researches to the engineering profession is most praiseworthy. The investigations by Naval Constructor Taylor at Washington were upon the effect of the shape of the bow and stern of a vessel upon the resistance. At an earlier date he had shown that the effect of the shape of the 'midship section of a ship upon resistance, while appreciable, was not great, and for the variations permissible in a given design would usually be almost negligible. The number of variations, however, that can be made in the shape of the hull toward the extremities is so great that it is not to be expected that the present investigations could cover the whole field. As far as they extend, however, they furnish a source of valuable information upon a hitherto debatable subject, and a careful study of the work will be very useful to designers. Professor Sadler's investigations upon the resistance of some types of merchant ships in shallow water are another example of the value of model-basin experiments for obtaining necessary data which ordinarily cannot be obtained in complete form from the performance of ships at sea. Experiments with navigable models for the solution of problems relating to the resistance and propulsion of ships are a somewhat new departure from former methods of doing such work, although they have been carried out in one or two instances in the design of a large, fast steamship, the results of which, however, have not been available to the public. The value of this means of investigation was clearly demonstrated before the society by Professor Peabody in a paper describing the results of a long series of experiments on such a model, the prototype of which was a revenue cutter tested by the author of the paper several years ago. In addition, a model of the ship was made and tested in the model basin at Washington, giving an exceptional opportunity to compare the actual observed power to drive the ship at certain speeds with the estimation of power from the resistance of the towing model, together with an estimate of the wake and thrust deduction from the navigable model. Important investigations of the effect of the pitch and area of the propeller on propulsion and the effect of a broad stern post and the location of the propeller with regard to the stern on the thrust and power required to drive the boat were made, and the results are a most welcome addition to the present knowledge of naval architecture. It is to be hoped that this experimental work will be continued in the future.

Besides the group of papers dealing with experi-

mental work on resistance and propulsion, several papers of interest were read regarding the recent developments in propelling machinery, including turbines, combination machinery, oil fuel and heavy oil engines. The possibilities of the different forms of propelling machinery were well set forth, and in some cases some very valuable data from actual practice were given showing the gain in fuel economy that can be made under certain conditions. It is usually difficult to obtain accurate data covering the performance of propelling machinery in merchant marine practice, because there is seldom an opportunity to make a complete series of tests, or, if such tests are made, the results are withheld for private use. The advent of the heavy oil engine as a prime mover in vessels requiring several hundred horsepower for propulsion has been too recent to furnish much indisputable data regarding its performance. The advantages claimed for the heavy oil engine are well known, but few have had sufficient experience with their use to give us much light on their disadvantages and the probable methods of overcoming them. In the paper presented on this subject the author goes into the mechanical problems connected with this type of engine in some detail, taking up the materials, piston speeds, lubrication, piston packing and stuffing-boxes. In summing up, he states that the only problems which have had to be solved are those due to the high pressures and temperatures in the cylinders. Whether the present solution of these problems has resulted in reliable action of the engine and immunity from frequent and extensive repairs remains to be proved.

While the naval architect is chiefly concerned with the problems of hulls and propelling machinery, there are some correlative subjects which have an important bearing upon his work. One of these, the question of marine terminal facilities, was brought before the society in a very comprehensive manner by papers dealing with the arrangement and equipment of a new marine terminal at Prince Rupert, British Columbia; the proposed improvements in dock facilities in New York, and the improvement of cargo transference at steamship terminals. These problems are constantly confronting those interested in shipping at nearly every seaport, and, while improvements have been carried out in some instances, greatly increasing the capacity of the port and reducing the cost of trans-shipments, in many others practically nothing has been done except minor changes by private interests which control only a small part of the dockage facilities, and, as a result, congestion in the movement of freight occurs.

Some light was thrown on this matter by the paper dealing with cargo transference, in which is shown the feasibility of increasing the rapidity of freight movements, of reducing the handling costs and of increasing the capacity of existing terminals by the adaptation of improved mechanical methods. Only the question of miscellaneous package freight was discussed, as methods for handling bulk freight have, as a rule, already been utilized to much greater advantage.

Another subject which has great influence on the design of ships, particularly those of the largest size, is the physical properties of seaports and harbors where limits on the draft of water of ships are necessarily imposed. As pointed out by Sir William White, the natural growth of the size of ships to meet the rapidly increasing development of maritime commerce has been accompanied by extensive and costly engineering work in deepening harbors and approach channels. As the cost of this work increases very rapidly with the depth, the main increase in dimensions of ships has been in lengths, breadths and molded depths; increase in drafts of water when fully laden having been relatively small. Further considerations of the maximum dimensions of ships by Sir William White in his paper on the subject are most timely, especially as the latest designs of transatlantic vessels are surpassing in size by a considerable margin the splendid achievements in the *Lusitania* and *Mauretania*. Current reports indicate that the advances made in dimensions by the *Olympic*, *Titanic*, *Aquitania* and *Imperator* are to be exceeded by a new White Star liner, which will probably be about 100 feet longer than the *Olympic*. This continuous growth in the size of vessels which must be accommodated in New York harbor emphasizes the importance of increasing the dock facilities in the port and adapting the harbor accommodations for maneuvering this class of ships, which, for commercial considerations, seem likely to maintain the transatlantic service in the future.

Many of those who were able to attend the meetings regretted that there was not more time to discuss some of the papers more fully. No matter how complete and valuable the papers presented before the society may be, there is much to be gained (and upon this a large share of the value of the society lies) from a thorough discussion of the subjects by those who have been associated with similar work in a variety of ways, and who are best fitted by their professional and practical experience to add much valuable information needed for the future progress of the work. One of the principal objects of the organization is for the interchange of professional ideas and opinions, making it possible to combine the results of research and experience in the many lines of work connected with naval architecture and marine engineering. Much discussion of the papers takes place outside the professional sessions, which, if there were more time, would take place in the meetings themselves. All this has aroused a general feeling that the annual meeting should extend over three days instead of two, as has been the custom. The continual growth of the society and its increasing importance in the engineering world are good reasons for extending the time allotted to its professional sessions for a more thorough discussion of the papers presented.

ENGINEERING SPECIALTIES.

The Kind Marine Diesel Engine.

Ing. P. Kind & Company, Turin, Italy, manufacture heavy oil internal-combustion engines for stationary plants, locomotives or for marine work. What is of most interest to-day is the reversible marine engine which is now being developed in two types—a heavy slow-speed engine for merchant marine work and light high-speed engines for fast ships and for warships. In the smallest reversible four-cylinder high-speed marine engines of 40 to 50 effective horsepower the number of revolutions vary from 500 to 650, while in the light high-speed engines of 3,000 effective horsepower the number of revolutions is reduced to 350 per minute. When the running expenses and endurance of the engine are the most important points under consideration, the number of revolutions in the normal type of Diesel engines is reduced to 150 per minute in the large sizes and to about 350 to 400 in the smaller engines By using bronze and the best qualities of steel the weight of the high-speed engines for naval purposes is reduced to 33 pounds per horsepower, while the weight of the normal light engines ranges from 44 to 66 pounds per horsepower.

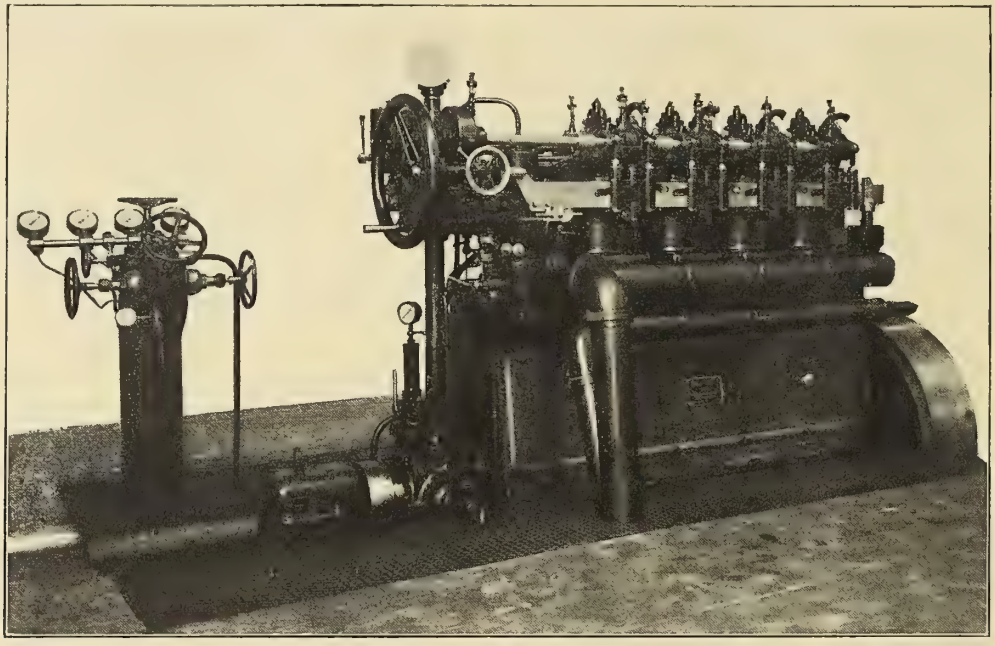


FIG. 1.

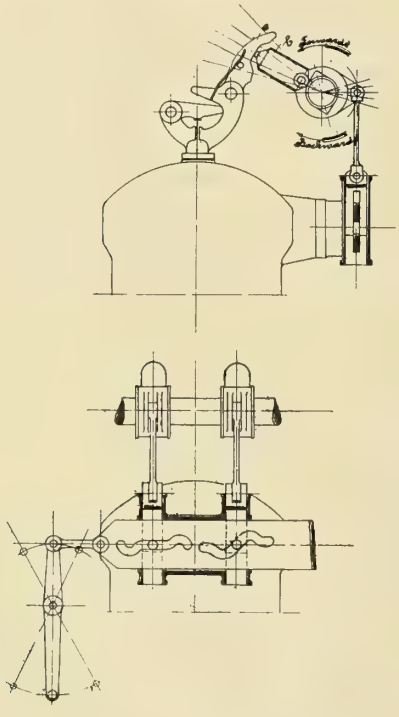


FIG. 2.

These engines are of the two-stroke type, and have either scavenging valves set in the cylinder head or scavenging ports, which the working piston opens after opening the exhaust ports. According to the type of the engine the scavenging air is furnished either by a special pump set attached to the engine, by an independent pump or by step pistons connected with each working piston.

Figs. 1, 2 and 3 show a 100-horsepower engine designed to run at 375 revolutions per minute. The cylinders are mounted on strong iron columns, and the crankshaft chamber is completely closed in by removable walls and is well ventilated. Each working piston in which the piston pin is fixed is furnished with a separable ring, which gives the necessary scavenging air for one cylinder. The scavenging flaps, which in engines of greater horsepower are substituted by piston valves, are set in the cylinder itself. In order to obtain a perfect combustion space and perfect scavenging, the scavenging valves are inclined. The scavenging cylinder is also separable from the working cylinder.

The distributing system and the maneuvering of the engine is quite different from any other type. In Fig. 3, which represents the fuel oil and air-starting distributing system, it is easy to see that through the displacement of the sliding piece *b* in a plane perpendicular to the cam shaft, the entire lifting diameter, corresponding to the profile of the cam, will be displaced at the corresponding angle, and that it is also possible to obtain the whole displacement corresponding to the reversing of the engine. During the same time, according to the form given to the curved piece *e*, and to the profile of the cam, the lifting corresponding to the cam is over the different positions of the sliding pieces *b*, totally, partly or not at all, transmitted to the valves. On account of the special form of the curved piece *E*, which receives the movement, and of the cam, it is possible to have any desired time for the beginning

and duration of the lifting, which is claimed to be a great advantage for running ships where great variations in the number of revolutions and in the power required must be taken into consideration.

While reversing of the scavenging valves is obtained by turning the cam shaft, the starting and fuel valves are reversed as explained above. The common displacement of the sliding pieces of both the starting and fuel valves' distributing system takes place through a rotative eccentric or a cam disk shaft, or through a removable curved ruler. This displacement, which is obtained through the movement of a single lever or hand-wheel, causes the starting, reversing and overloading and any desirable speed changes in the engine. This same maneuvering device controls at the same time the distribution of oil fuel in the oil fuel pump and the control of the starting air when necessary, and causes the turning of the cam shaft in order to reverse the scavenging valves when necessary. When reversing the engine there is a speed device which prevents the introduction of fuel oil while the engine is still running in the opposite direction. In the engine shown in the illustration the circulating water is furnished by a centrifugal pump, and the filtered lubricating oil for lubricating the crankshaft and connecting rods and for cooling the working and scavenging piston is furnished by a wheel pump. The air injection pump is a two-stage pump, with suction directly to the atmosphere.

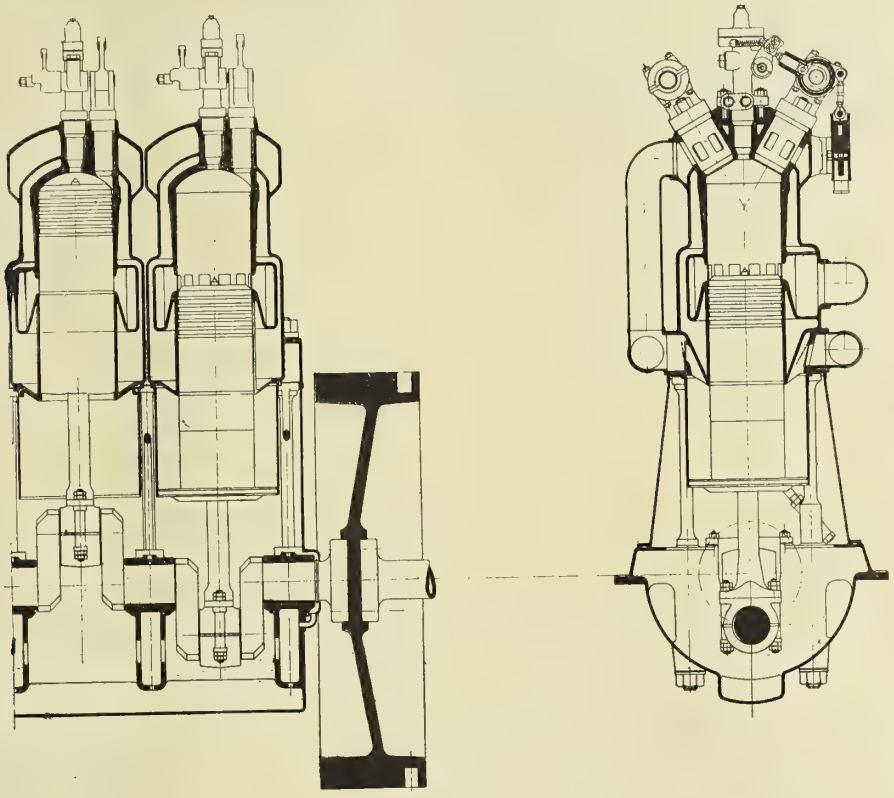


FIG. 3.

An Electric Punkah.

Messrs. Hogan & Wardrop, of 2 Gresham buildings, Basinghall street, London, E. C., have recently put on the market a new form of electric fan, which is a directly-driven punkah. The essential "flick" at the end of the stroke, which long experience has enabled the India punkah wallah to develop into an art, is exactly reproduced in this present fan, and occupying little head room it is especially suitable for marine use, but can, of course, be arranged to suit any height of ceilings. A general view of the punkah is shown herewith, and, as will be seen, it comprises a motor working horizontally, and by means of worm reducing gear the speed is brought down to about forty strokes a minute; the rotary motion of the motor is mechanically converted to a rectilinear action by the connecting rod secured directly to the rigid frame of the punkah.

Another point in the use of this type of fan which will appeal to the thoughtful reader is that on account of the intermittent character of the wavelike disturbance of air given by the motion of the fan there is not the objectionable draft produced by the steady blast of air which is characteristic of the ordinary rotating fan blade.

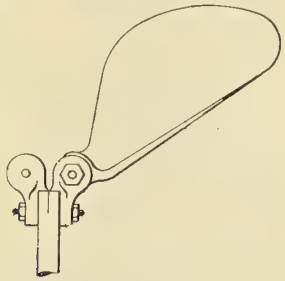
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,002,796. PROPELLER. GUIDO ANTONI AND UGO ANTONI, OF PISA, ITALY.

Claim 1.—A propeller adapted for water or aerial navigation comprising a driving hub and a blade rigidly and immovably connected



thereto and having a diminishing thickness in a direction from its root to its periphery or tip and from its leading edge to its following edge which renders the thinner portions of the blade capable of flexing under the influence of the medium upon which the blade acts. Two claims.

1,002,184. APPARATUS FOR RAISING SUNKEN VESSELS. JOSEPH B. SERRES, OF HOULTONVILLE, LA.

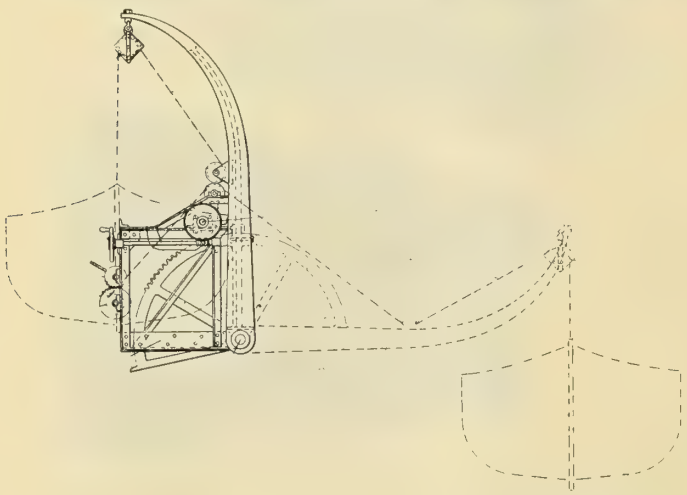
Claim 1.—A pontoon, upper and lower conduits in said pontoon, a valve controlling each of said conduits, the valve of said lower conduit being provided with a rod extending within said pontoon, and a float pivotally mounted within said pontoon, and connected with said rod. Three claims.

1,002,033. LIFE-SAVING DEVICE FOR SUBMARINE VESSELS. DAVID CHAPPELL, OF LLANELLY, ENGLAND, AND JOHN CHAPPELL, OF PITTSBURG, PA.

Claim 2.—In a life-saving device for vessels, the combination with a vessel having the shell thereof provided with an opening, of a casing suspended from the edges of said opening, a life boat fitted in said opening and having the top thereof closed, anchoring screws carried by said life boat for retaining said life boat in said casing, releasing screws carried by said life boat and adapted to elevate said life boat relatively to said casing, said casing, life boat, and the closed top thereof having manholes formed therein, and trap doors normally closing said manholes. Two claims.

1,002,032. DAVIT. WILLIAM L. CHAPMAN, OF NEW YORK, N. Y.

Claim 1.—In a davit apparatus, the combination of frames adapted for attachment to a vessel or support, davits fulcrumed on horizontal pivots at approximately the lower and outer limit of said frames, the upper extremities of said davits extending both inboard and toward each other, whereby the initial outboard movement of the davits tends to raise the

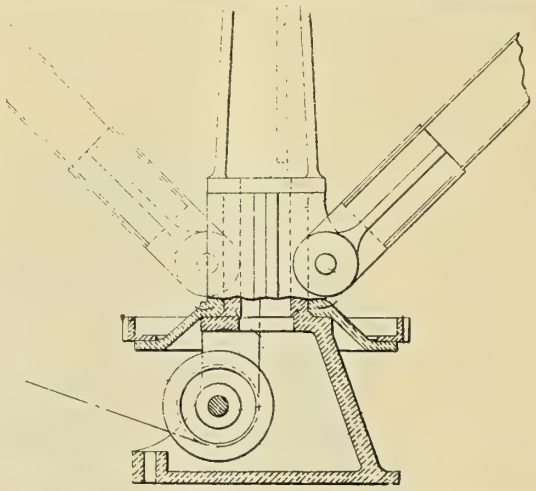


boat from its chocks, and whereby the ends of the boat may readily swing past the davit, toothed sectors in fixed relation to said davits respectively and extending upward and inboard from the pivots thereof, and gearing engaging said sectors for swinging the said davits outboard. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

21,259. SHIP'S DECK CRANE. J. PATTERSON, GLASGOW.

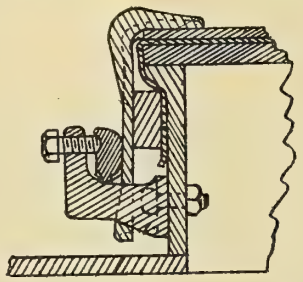
The invention relates to that type of slewing crane for ships' decks in which, while the jib is slewable about a fixed post, the gearing and motor operating it are stationary. The invention provides an improved arrangement of the lower fair lead pulley in that, while slewing in a com-



plete circle, the whole may be arranged above the sole plate. The jib is pivoted on a collar-like member made in halves and bolted together about a cylindrical part formed near the lower end of the post. This member bears a toothed wheel by which it is operated from the fixed motor. By the invention the base is enlarged and gapped on the side next the winding barrel and on a spindle within this base is a fair lead pulley capable of moving endwise. To this fair lead pulley the rope passes down axially to the fixed post, from a pulley carried upon a collar, to which are attached the jib guys, and which is thus constrained to move with the jib and the collar-like member.

28,340. HATCHWAY FASTENER. M. MULHOLLAND, CLEVELAND, OHIO, U. S. A.

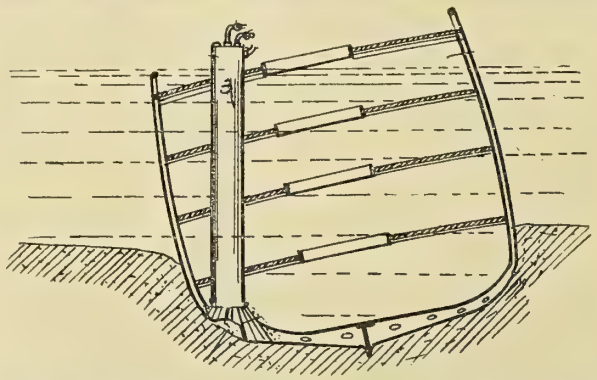
With this fastener a clamp-arm is slipped over a bracket attached to the coaming so as to press against the battens and strips which lie outside the



canvas. The keeper is then swung on its pivot so that its wedge-head is interposed between the screw and the clamp-arm to instantly force the latter down the incline upon the batten, and horizontally against the strips, while locking it in place.

16,594. TEMPORARILY REPAIRING THE HULLS OF STRANDED OR SUNKEN VESSELS. S. McGILL, OF NEWCASTLE, N. S. W.

Relates to a tube to be inserted through the decks and extending to



the seat of the injury, where it is provided with a petticoat part for surrounding the injured part. Through this tube workmen may descend and effect repairs to allow the salving of the ship, an air lock and air supply being arranged.

TRADE PUBLICATIONS.

AMERICA

Hydraulic jacks and tools of all sorts are described in catalogues published by the Watson-Stillman Company, 188 Fulton street, New York. This company's types and sizes of jacks cover a wide range of capacity and permit one man without severe effort to move any weight up to 500 tons. "Watson-Stillman hydraulic jacks being heavy for their rating have a greater safety factor and handle a large overload safely. Thoughtless workmen often put a pipe on the handle of a hydraulic jack to increase the power. We provide liberally for just such emergencies."

"American Vanadium Facts," published by the American Vanadium Company, Frick building, Pittsburg, states under its Trade Facts column that "Where tools are used under conditions that admit of danger to the operator, the integrity of the tool for the purpose of insuring the workman from injury is a matter of first importance. The use of vanadium steel parts in the Vulcan chain pipe wrenches, made by J. H. Williams & Company, Brooklyn, not only gives a decided increase in strength, but a larger factor of safety that is ample protection to the operator. The Bourne-Fuller Company, Cleveland, Ohio, announces that 75 percent of its trade is buying Scott's unique high-speed steel (chrome-vanadium) for pneumatic and other chisels with the best results."

Milling Cutters.—Milling cutters have become an everyday tool and have been improved constantly, and can be obtained now in almost any size and form. Catalogue 18-A of the Standard Tool Company, Cleveland, Ohio, gives prices and descriptions and sizes of an endless number of most admirably designed milling machine cutters. The skill required to make high-grade milling cutters is not appreciated, as the machine world has got used to almost perfection in this line. Yet the selection of proper steels, its hardening and treatment, the form of the cutter, etc., demand study and close attention and a very long purse to carry out experiments and get proofs which alone finally carry conviction to the customer and a pleasant sensation to the manufacturer that his product will not only sell but stay sold. The company named above aims to produce only cutters of the very highest grade, and their catalogue gives every information concerning them, and it is certainly a pleasure to look over.

"Steam Turbine Centrifugal Pumps and Other Centrifugal Machinery" is the title of a 32-page booklet, or album, issued by the De Laval Steam Turbine Company, of Trenton, N. J., illustrating and describing briefly the several lines of machinery manufactured by that concern, including single-stage turbines for driving machinery of all kinds and for rope and belt transmission; turbine-driven centrifugal pumps for water-works, for general water service in industrial plants, and for boiler feeding, hydraulic pressure work, etc.; velocity-staged turbines without gears for direct connection to high-pressure blowers, centrifugal pumps, etc.; multi-stage impulse turbines with gears for driving large direct-current generators, fans, centrifugal pumps and other moderate or low-speed machinery; multi-stage impulse turbines without gears in large sizes for direct connection to high-speed alternators; motor and belt-driven centrifugal pumps for all services and heads; multi-stage centrifugal air compressors and De Laval speed reduction gears for various services. Copies of this booklet will be sent upon request to those interested.

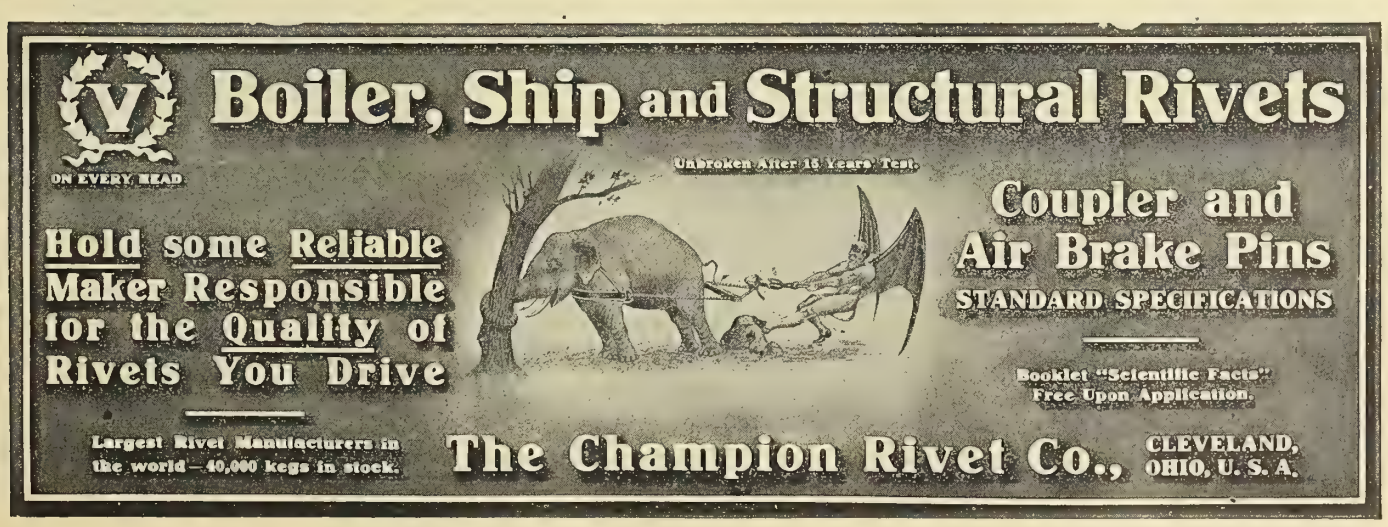
"File Filosophy" is the title of a booklet published by the Nicholson File Company, Providence, R. I. This is a complete work on different styles of files and their uses, and a copy will be sent free to any of our readers upon application.

Heavy oil marine engines are described in a pamphlet of 22 pages published by the New London Ship & Engine Company, Groton, Conn. These engines are sold under a positive guarantee as regards fuel consumption, which is stated to average less than ½ pound per horsepower-hour. Fuel costs 2 to 3 cents a gallon. This is stated to be the ideal motive power for power boats, tugboats, yachts, barges, fishing and sailing vessels, cargo vessels and fast passenger vessels. It is built in units of from 50 to 2,500 horsepower. Two types, heavy, of about 80 pounds per horsepower, light, of 40 pounds per horsepower. They are reversible and self-starting.

The Lyle line-carrying gun for steamships and towboats is described in a catalogue published by William Read & Sons, 107 Washington street, Boston, Mass. This company also makes a breachloading line-carrying shoulder gun, which is stated to be small and compact, readily carried by hand, and invaluable for lifeboats, large yachts and towboats in picking up a wreck at sea and in allowing one boat to approach another in a heavy sea at a safe distance. Projectiles are of the Lyle type as used by the government life-saving stations, and will carry the line from 200 to 400 feet. William Read & Sons state that about thirty of these guns are in use on board United States revenue cutters. All interested should write for a copy of this catalogue and mention INTERNATIONAL MARINE ENGINEERING.

Monel metal propellers are described in circulars issued by the Ruggles-Coles Engineering Company, 50 Church street, New York. The United States torpedo boat destroyers *Fanning, Perkins, Roe, Sterrett, Terry* and *Walke* are each equipped with three-bladed Monel metal propellers made by the Bayonne Casting Company, of which the Ruggles-Coles Engineering Company is the general agent. The statement is made that Monel metal propellers stand up to the terrific high speeds of torpedo boat destroyers with a minimum distortion; that they withstand the shocks better than manganese bronze and retain their polish longer, their finish being similar to pure nickel. Merchant ships as well as naval ships are equipped with these propellers, and the Ruggles-Coles Engineering Company is prepared to make quotations on any size up to 27,000 pounds weight in one piece.

Oil fuel burners for marine, stationary and locomotive furnaces are described in circulars published by the Ingram Oil Fuel Burner Company, Box 206, Newport News, Va. "This burner is equally effective with either steam or air as the atomizing agent, and is not affected by a reasonable amount of water in the oil. It is highly efficient with very low-pressure on both the oil and the atomizer, and the best results are obtained with 70 pounds on the steam and 50 pounds on the oil. Preheating the oil is unnecessary, and by its use the danger and the worry due to leaky joints in pipe lines conveying oil at a high temperature and under heavy pressure are obviated. We do not handicap the users of our burners with a multitude of don'ts to confuse the operator, as they are so simply constructed that the minimum of skill and intelligence is necessary for their successful operation. Should you still be doubtful as to our claims we invite you give them a practical test at our expense."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Over 1,000 Blake marine pumps sailed out of New York harbor Nov. 2 on the Atlantic fleet. Of the 102 warships of this fleet sixty-five are equipped with Blake pumps, and of the remaining thirty-seven nine carry no steam pumps and eight were built abroad. Send for Catalogue BK 106-43, published by the Blake & Knowles Steam Pump Works, 115 Broadway, New York.

A complete tool catalogue is published by the Billings & Spencer Company, Hartford, Conn. Among the large number of tools described in this catalogue are four sizes of combination pliers, which the Billings & Spencer Company states are the original pliers first marketed by the company thirty years ago, and standard to-day. Like all this company's tools they are guaranteed.

Gages for pressure and vacuum are described in Catalogue M-1 published by the Schaffer & Budenberg Manufacturing Company, Brooklyn, N. Y. This company makes a gage for every conceivable purpose and is also prepared to do repair work of every description on any instrument, whether it is of its own manufacture or not. Owing to the company's extensive facilities its charges are stated to be extremely moderate.

Blow-off valves are the subject of an illustrated catalogue published by the Nelson Valve Company, Philadelphia, Pa. These valves are made of iron for 300 pounds working pressure, and steel for extreme service. "We guarantee the Nelson blow-off valve. It is patented. Its name is trademarked. We couldn't afford to put our name on it if it was not right. If after sixty days of use you are not satisfied send back the valve and we will refund the price you paid for it."

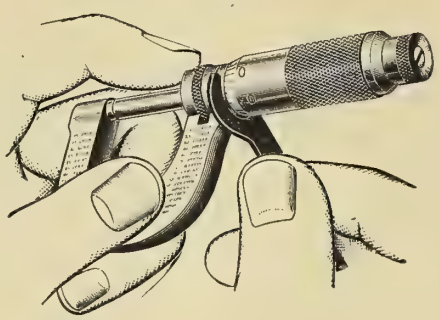
A combined jaw and friction clutch is described in a folder published by the Positive Clutch & Pulley Works, 30 Lansing street, Buffalo, N. Y. "The combined jaw and friction clutch combines the advantage of a friction clutch, to gradually pick up the speed of a driven shaft or pulley, etc., under load, with the positive drive of a jaw clutch. The frictions are not obliged to carry the load, but are used only for the purpose of operating the jaws."

"Why spend $8.00 for gasoline or $3.00 for steam when you can get the same power for $1.00?" is the question asked in a catalogue published by the Marine Producer Gas Power Company, 2 Rector street, New York, manufacturer of producer-gas plants. The company makes these plants in sizes from 25 to 5,000 horsepower, and states that they can be used with almost any gasoline engine. The catalogue gives full information on how to install and operate a producer-gas plant.

What Kerr turbines are doing in United States government service is the subject of a catalogue published by the Kerr Turbine Company, Wellsville, N. Y. "Government officials make no purchases foolishly. The investigations and specifications are rigid, and final acceptance is based upon tests that are thorough even to minute details. It is therefore significant that Kerr turbines have met every government requirement for efficiency, regulation, steam consumption, temperature, etc., and that thirty-five Kerr turbines averaging over 150 horsepower each are now giving satisfactory service in government lighthouses, public buildings, training schools, navy yards, arsenals and on the ships of the United States navy."

"Plymouth Products" is the title of a series of booklets published by the Plymouth Cordage Company, North Plymouth, Mass. Plymouth strength is made by certain tests, as all Plymouth rope is said to go through rigid inspection. An illustration in one of this company's catalogues shows one of these inspections, in which a 45,000-pound pull failed to snap a 7½-inch rope, although it was only expected to hold 43,000 pounds. Plymouth rope is especially recommended for tug hawsers, which get the hardest kind of usage. Rope used in this work generally goes to pieces quickly, making wearing power a question of vital importance.

Just what you have been looking for in a Scotch boiler—rapid circulation—is found in the Robb-Brady type, according to Bulletin No. 3, just issued by the Robb Engineering Company, Ltd., South Framington, Mass. "Positive circulation without a pump or other device. The circulating passage around the boiler empties below the furnace. Hot water and steam must flow up between the furnaces and pass to the steam drum through the rear neck. The combustion chamber is cylindrical—no flat top, no girder or crown-bar stays. No longitudinal stays. Special hand holes for cleaning rear tube sheet. Built in sizes from 50 to 300 horsepower. Working pressure up to 225 pounds."



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of the Starrett Micrometers is a feature that enthuses all mechanics. It takes up any wear quickly and accurately—not by the trial hit-and-miss way of the movable anvil. This is obtained by placing over the barrel a thin, graduated sleeve, which carries the base or zero line, instead of having it marked on the barrel itself. If, at any time, on account of excessive wear, the zero line is not correct, a small turn of this sleeve with a small spanner wrench will remedy the error. A wrench is sent with each micrometer.

Catalog 19L is free.

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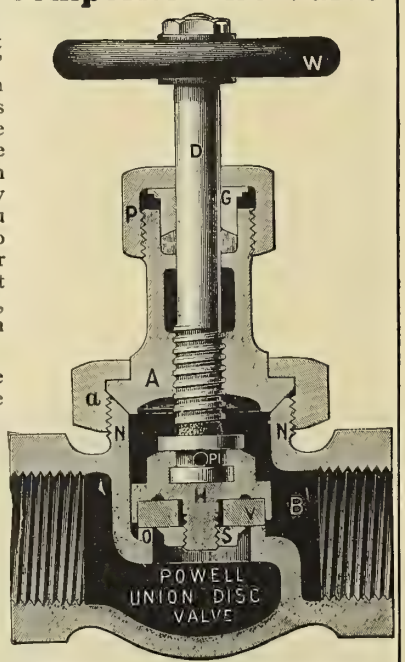

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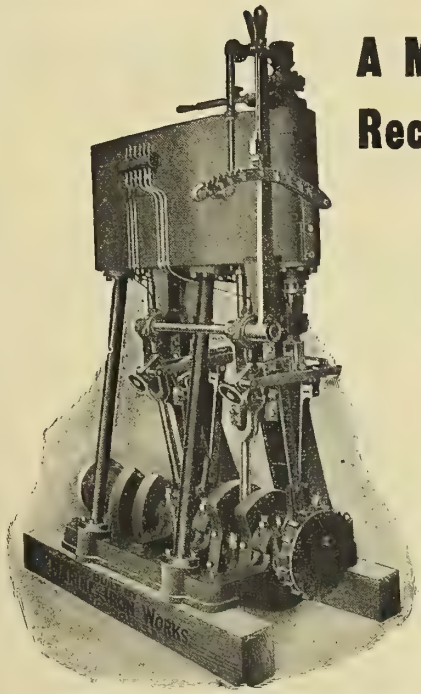

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Marine Machinery Specialists

New folder on "Diamond" front end soot blowers. A lot of sound, hard-headed logic on fuel economy has been worked into the new 12-page folder just issued by the "Diamond" Power Specialty Company, Detroit, Mich., on its front end soot blower for marine work. Anyone connected with the marine trade and interested in saving fuel should send for a copy of this two-colored illustrated folder.

The simple adjustment of the micrometers made by the L. S. Starrett Company, Athol, Mass., is a feature that is stated to be especially appreciated by all mechanics. It takes up any wear quickly and accurately, "not by the trial hit-and-miss way of the movable anvil." Micrometers are only a few of the large number of instruments of precision described and illustrated in Catalogue 19-L, which will be sent free upon application to any of our readers.

"Keystone Grease" is the title of an illustrated booklet published by the Keystone Lubricating Company, Department V, Philadelphia, Pa. "This booklet comprises a general treatise on the several densities or consistencies of Keystone grease. It outlines and describes the difference between their general make-up as well as thoroughly designating the general class of machinery which each one is physically appropriate to lubricate. There is also described the proper, correct method by which each density should be used and applied to the various classes of machinery bearings. Correct application contributes very considerably to the achievement of maximum good results from the use of Keystone grease; so we, therefore, earnestly impress upon the engineer or person intending to test or use Keystone grease the importance of reading over, thoroughly, this booklet and applying the grease according to instructions."

Another edition of the "Smooth-On Instruction Book" has just been issued by the Smooth-On Manufacturing Company, 572 Communipaw avenue, Jersey City, N. J. This book tells all about Smooth-On iron cements, sheet packings, corrugated metal gaskets, and shows when, where and how to use them. "The great value of Smooth-On to the manufacturer and user is because of its peculiar chemical properties, namely, of metalizing and of expanding when metalizing, and it can be prepared to act quickly or slowly, according to the requirements of particular uses. These properties make Smooth-On a valuable substance in the making of chemical iron cements. To this subject the chemist of the Smooth-On Manufacturing Company has given careful study for fifteen years, and has succeeded in compounding the valuable iron cements known so generally throughout the world as Smooth-On iron cements. These cements are made each for a special purpose; they are carefully prepared by a chemist, and when correctly used they make permanent repairs. The different Smooth-On cements are explained in the following pages; a careful study of them will prove interesting and profiable. The illustrations are made from photographs of actual subjects, and show some of the many ways in which the Smooth-On cements have been used and the results obtained."

The use of the triplex chain block in the lifting of loads is the subject of a booklet published by the Yale & Towne Manufacturing Company, 9 Murray street, New York. A free copy of this booklet will be sent to anyone mentioning this magazine. "The lifting of loads is a universal need—a vital factor in every man's business. The triplex block is the simplest, safest, most efficient and most economical load lifter in the world. It lifts loads under all conditions, in all places, from a palace to a sawmill, a garage to a warship. When one man pulls on the hand chain of the triplex block he can lift any load from 200 pounds to 20 tons—two men can lift 40 tons. The load is always automatically held at any point during the lift. You can go away and let it hang ten seconds or a year. It will not come down until you are ready. Then you lower it by pulling lightly on the reverse side of the hand chain. The triplex block has the strongest, simplest, smoothest-running, wear-resisting system of gears ever devised to multiply lifting power. It so multiplies the strength of one man as to make him master of every lifting problem. Many loads must also be transported—moved horizontally. The triplex block not only lifts its load easily, and holds it suspended safely, but when hung from a trolley running on an overhead track the load may be moved easily wherever the overhead track goes. One man can push the load as easily as he lifts it. In foundries, machine shops, factories, sawmills, mines, quarries, warehouses, in power houses and boiler rooms, on railways, ships and docks, thousands of triplex blocks are daily lifting and transporting thousands of tons, at a saving in labor which frequently repays the whole cost of installation in six months. Everyone who has lifting and transporting to do should write for the book about triplex blocks. A postal brings it."

Oil engines of 2 to 600 horsepower are described in a catalogue published by A. Mietz, 130 Mott street, New York. These engines use kerosene, fuel oil, crude oil and alcohol, and Mr. Mietz states that 150,000 horsepower are in operation.

"Be Ready for the Long Dark Nights" is the title of Bulletin No. 22 just issued by Kerr Turbine Company, Wellsville, N. Y., describing and illustrating installations of their turbo-generator sets for lighting. This folder is well worth reading by any one who is figuring on an independent lighting plant. A copy will be sent upon request.

The new "Buffalo Book" is now on the press, and every one of our readers who is interested in gasoline motors of any size and for any purpose should write to the Buffalo Gasolene Motor Company, 1209-21 Niagara street, Buffalo, N. Y., for a copy. This books tells all about the new models and the refinements of design which mark the 1912 "Buffalos."

"Ready-to-Run" ventilating sets are described in Booklet MC-9 published by the B. F. Sturtevant Company, Hyde Park, Mass. "Originally designed for ventilation their development for other uses has been nothing short of wonderful. They require no installation work, simply unpack; plug the cord into the light receptacle and turn the switch. They are built in five sizes, with capacities from 35 to 1,250 cubic feet per minute."

The Whitney portable hand metal punch No. 1 is described in circulars issued by the W. A. Whitney Manufacturing Company, Rockford, Ill. This punch is especially constructed for boiler, tank and stack work and structural builders' requirements. The weight is 21 pounds. It has detachable pipe handles, and the capacity is a 9/16-inch hole through ¼-inch boiler plate.

"The Whole Kewanee Family" is the title of a booklet published by the National Tube Company, Frick building, Pittsburg, Pa. Among the advantages claimed for the Kewanee union are: Brass to iron thread connection—no corrosion; brass to iron ball joint seat—no gasket; 125 pounds compressed air test under water—no defective fittings; solid three-piece construction—no inserted parts; easily disconnected—no force required.

Every engineer and ship and engine builder should send to the Lunkenheimer Company, Cincinnati, Ohio, for a free copy of its new catalogue of engineering specialties. This is a booklet of several hundred pages profusely illustrated, and describing a very complete line of engineering specialties, such as valves, cocks, whistles, oil cups, etc.

Sirocco Bulletin No. 284-ME has just been published by the American Blower Company, Detroit, Mich. It describes and illustrates fans for mechanical drive and ship ventilation. These fans are claimed to have enormous volumetric capacities for small space requirements, and being small the cost of installation is brought down to the minimum.

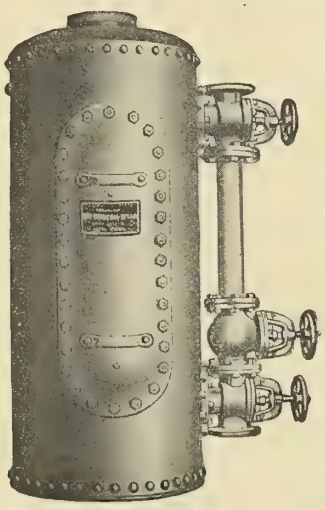
TRADE PUBLICATIONS

GREAT BRITAIN

The Falcon Iron Works, Ltd., Oldham Lanes, have issued a number of pamphlets containing illustrations and details of winding or hauling engines of different patterns from 5 brake-horsepower to 1,000 brake-horsepower, including the ordinary geared engine, worm geared capstan engines, endless rope haulage gear and long-type of engine. Electrically-driven haulage gears are made in sizes from 5 brake-horsepower to 500 brake-horsepower. Details are also given of the "Falcon" friction clutch, the automatic tub axle greaser, and a patent rope haulage clip.

Feed Heater Heaters are described and illustrated in a new List (No. 211) issued by Holden & Brooke, Ltd., of Sirius Works, West Gorton, Manchester. These are made on Brooke's patent "High Velocity" system. It is claimed by the firm that "by virtue of this system alone, as has been proved by quite independent investigations, the maximum heat extracting capacity of metal surfaces is obtained, and consequently the highest temperature of feed water." The principle of this system is based upon the fact, not generally appreciated, that heat transmission is dependent upon maintaining the greatest possible degree of difference in temperature on the two sides of the heating medium; and it is urged that, in practice, by the "High Velocity" system feed-water can be delivered 20 percent hotter than by ordinary heaters.

Reilly Multicoil Heaters



and **Evaporators** are **in stock** at the shops, Pier B, Jersey City, awaiting your rush orders. Coiled, flexible copper tubes, ground union joints (no expanded ends), and the Reilly manhole door, giving access to all interior parts, give the marine engineer an auxiliary which **saves coal, increases Condenser capacity,** and needs **no repairs.**

Send your vessel to our pier for her next repairs; and install the auxiliaries at the same time.

Reilly Multicoil Evaporators Improved Type

?

Do you want to know?

THE GRISCOM-SPENCER COMPANY

90 WEST STREET, NEW YORK.

FORMERLY THE JAMES REILLY REPAIR AND SUPPLY COMPANY.

Night signaling at sea by flash lamp is described on a circular published by the Signaling Specialties Supply Company, 59 Fenchurch street, London, E. C. "Endall's Morse code lamp is the only signaling apparatus which, in addition to making an 'all-round' or general signal, enables the operator to direct a message to any desired quarter, thus giving an 'individual' or private signal."

The Cooper roller bearing, made by the Unbreakable Pulley & Mill Gearing Company, Ltd., 56 Cannon street, London, is described in circulars the manufacturer has just issued. "As specialists in the mechanical transmission of power we have carefully watched the performance of the various types which have appeared—and for the most part disappeared. First came the solid roller of mild steel running directly on the journal—result, mutual destruction with anything but comparatively light loads. In the hope to preserving the surfaces, rollers of the 'flexible' type were introduced, made either of rolled plate or spirally-wound spring steel. The former were liable to fracture, which meant stoppage of rollers and immediate or subsequent trouble. Under heavy loads the other 'flexible' type require to be closely watched, because of the liability of the rollers to elongate, in which case sufficient end pressure on the cages and housings is set up to interfere with their free running. Unless this is immediately detected and the bearing dismantled, and the spiral rollers shortened, the complete bearing and the shaft will be damaged, if not ruined. To protect the shaft journal and confine the damage to the parts less costly to renew, thin sheet steel liners are sometimes provided. With this type, whatever may be the saving claimed or effected, there is undoubtedly grave risk of damage, and, what is worse, of stoppage. It is only roller bearings in which all bearing surfaces are hardened and ground that have in our experience proved their durability in heavy service. The majority of these, however, have been fitted with rollers of small diameter and considerable length, and, being hardened right through, these are apt to fracture. Further, owing to the annular space available for the cage being narrow, and the cage itself relatively long, it cannot be made sufficiently stiff to maintain the rollers in true alignment."

The Perco patent power hammer is described in the literature published by Perkin & Company, Ltd., Junction Works, Leeds. "The hammer head will accommodate dies for a great variety of work. The length of stroke can be adjusted. It is strongly built of best cast steel and iron, and, having no complicated parts, it is easily repaired should anything get out of order. All working parts are at the top, in full view of the workman. The hammer head, anvil, guides, glands on the crank plate and crank pin with nut, also friction coupling and strap pulley, are turned or planed. There are flanges on the crosshead against the outer side of the guides, to hold them in position, and on the one side of the crosshead there are set screws to regulate the position of the guides when worn. All wearing parts are large and carefully made. The four columns carry the top plate with driving shaft, pulley and friction coupling. The friction clutch is fitted with a brake, working automatically when the coupling is disengaged, and the hammer stops instantly, with the ram always at a certain distance from the anvil. The coupling is easily operated by the treadle, and the blow can be better controlled by the foot than in any other way. The hammer head runs in planed guides, always maintaining a true vertical position at every point, and is thus capable of doing accurate and rapid work. The guides, which are of steel, are adjustable and easily renewed. The motion is applied to the head or ram by means of a connecting rod (sliding in a sleeve or collar, and fastened by a set screw) and a strong bow spring with iron straps. The spring is of best open-hearth steel, carefully hardened, and the straps of wrought iron. By means of the spring and the connecting straps the strength of the blow is much increased, as the ram from the rebound of its blow on the material being forged, and from the action of the connecting rod, is quickly drawn up, thereby contracting the spring. This accumulated power is then released in the next fall."

BUSINESS NOTES

AMERICA

THE STEAMERS *Seaconnet, Penobscot, F. J. Lisman* and *Mary E. Harper,* owned by the Harper Transportation Company, Boston, Mass., have all been recently equipped with "Diamond" front end soot blowers, made by "Diamond" Power Specialty Company, Detroit, Mich.

COBBS HIGH PRESSURE SPIRAL PISTON

And VALVE STEM PACKING

IT HAS STOOD THE TEST OF YEARS AND NOT FOUND WANTING

IT IS THE MOST ECONOMICAL AND GREATEST LABOR SAVER

WHY? Because it is the only one constructed on correct principles. The rubber core is made of a special oil and heat resisting compound covered with duck, the outer covering being fine asbestos. It will not score the rod or blow out under the highest pressure.

NEW YORK BELTING AND PACKING CO. LIMITED

91 and 93 Chambers Street, NEW YORK

LONDON, E. C., ENGLAND, 11 Southampton Row

CHICAGO, ILL., 130 WEST LAKE STREET
ST. LOUIS, MO., 218-220 CHESTNUT STREET
PHILADELPHIA, PA., 821-823 ARCH STREET
SAN FRANCISCO, CAL., 129-131 FIRST ST., OAKLAND
BOSTON, MASS., 232 SUMMER STREET
PITTSBURGH, PA., 420 FIRST AVENUE
PORTLAND, ORE., 40 FIRST STREET
SPOKANE, WASH., 163 S. LINCOLN STREET

THE UNITED STATES GOVERNMENT'S REPRESENTATIVE at the Turin Exposition has notized the International Acheson Graphite Company, Niagara Falls, N. Y., through the Department of the Interior, Bureau of Mines, in Washington, that the Jury of Awards of that Exposition has awarded that company a grand prize on the exhibit of its products.

RECENTLY A TERRY TURBINE centrifugal pump set was installed on the United States battleship *Arkansas,* and it is said that this is the first time a steam turbine has been adapted to this use on any naval or mercantile vessel. On land turbo-pump sets have been extensively used for a variety of purposes with the most satisfactory results, and it is anticipated that they will fulfill all expectations in marine work.

THE STEAM YACHT *Carmina,* owned by Mr. F. S. Smithers, is being laid up for the winter at Tebo's yacht basin. We understand that the boilers which were installed in the spring by the Roberts Safety Water Tube Boiler Company, Red Bank, N. J., made ample steam without the aid of the blowers that were used with the watertube boilers that were removed. The *Carmina* cruised more this season than last year, and was capable of making 2 miles better speed under natural draft over and above that done by the former boilers with forced draft, and at the same time her total coal bill for the past season was less than formerly.

"THE TURBINE-DRIVEN FAN FOR FORCED DRAFT is now the accepted standard in the United States navy, taking the place of the former forced draft sets consisting of fan driven by high-speed engine. These engine-driven sets on the older boats of the navy were a source of much trouble and occasioned frequent breakdowns. The new turbine sets deliver 28,000 cubic feet of free air per minute against 5-inch static pressure water gage in the stokehold. Two sets are placed in each stokehold, and the turbine is hung from girders directly beneath the ventilator cowls. Of the eight United States destroyers recently contracted for, seven will have four Terry turbine-driven forced draft sets. These destroyers are the largest and most powerful ever built in this country, and are equipped for burning oil fuel. Of the twenty-one oil-burning destroyers previously ordered by the government seventeen are equipped with Terry turbines. The uniform success of these destroyers is in a measure due to the very satisfactory operation of the turbine-driven blowers."

AMONG THE FOREIGN ORDERS recently received by the Terry Steam Turbine Company, Hartford, Conn., are three turbine-driven blowers for Chinese cruisers and a 15-kilowatt turbo-generator set for Russia.

THE PUSEY & JONES COMPANY, Wilmington, Del., has just placed an order with Ruggles-Coles Engineering Company, 50 Church street, New York City, general agents for the Bayonne Casting Company, Bayonne, N. J., for two 66-inch propellers to be cast of "Monel" metal for a large private yacht which they are building.

THE MAIN OFFICES of A. Eugene Michel and staff, advertising engineers, have been moved into the Park Row building, 21 Park Row, New York, where larger space has been secured, as necessitated by constantly increasing business. Temporarily the photo retouching and illustrating department will remain in the Hudson Terminal buildings, but all business will be managed from the new offices.

THE BUSCH-SULZER BROS. DIESEL ENGINE COMPANY, South Side Bank building, St. Louis, Mo., announces that by virtue of purchase and agreements with Mr. Adolphus Busch, purchaser of the American Diesel Engine Company, Messrs. Sulzer Bros., Winterthur, Switzerland, and Dr. Rudolph Diesel, Munich, Germany, the company is the exclusive owner of patents, manufacturing and selling rights for the United States and Canada. Parties interested in this type of engine, either for marine or stationary work, are invited to correspond with the company. The Eastern sales office is 11 Broadway, New York, Mr. W. R. Haynie manager.

MR. C. R. VINCENT, for many years president of the Ball & Wood Company, has assumed the managership of the "Monel" metal department of the Ruggles-Coles Engineering Company, 50 Church street, New York City, general agents for the Bayonne Casting Company. At its foundry in Bayonne, N. J., the latter company has for some years been making with success castings of this remarkable alloy, that is said to be stronger than steel and less corrodible than bronze. Some of these castings range over 25,000 pounds in weight. Sheets, rods, wire and screens of the same metal will also be handled by the company with which Mr. Vincent is associated.

WELIN DAVIT AND LANE & DE GROOT CO.

305 Vernon Ave., Long Island City, N. Y. CONSOLIDATED *Tel. Greenpoint 2581*

Manufacturers of ***Welin Quadrant Davits,*** *the only reliable boat-launching apparatus on the market; manufactured in twenty distinct types and sizes.*

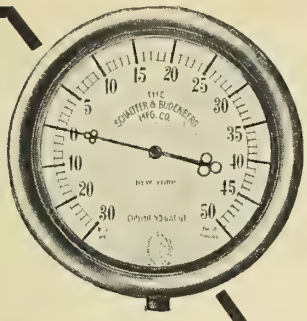
Over 4000 Davits now in use.

Steamships "OLYMPIC and "TITANIC" fitted throughout with Welin Quadrant Davits

The ***Lane & De Groot Life Boats*** *and* ***Life Rafts*** *are the Standard of quality.*
Also builders of bronze, steel and wooden launches and other marine appliances.
The famous ***A-B-C Life Preservers.*** *One-third lighter and smaller than any other belt made.*
All our appliances approved by U. S. Inspectors.

London House: **THE WELIN DAVIT & ENGINEERING CO., LTD.** *5 Lloyd's Avenue, London, E.C.*

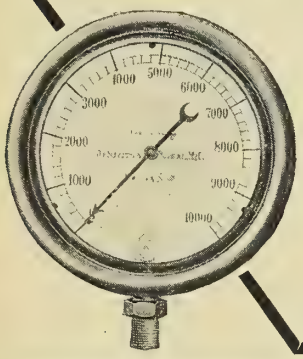
Gauges



The S. & B. line of Gauges for pressure and vacuum is complete. We have an instrument for every conceivable purpose. Moderate-priced instruments of highest quality. They are all described in our Catalog M-1. *Obtain a copy.*

Repair Work

We are prepared to do repair work of every description on any instruments, whether they be of our own manufacture or not. And owing to our extensive facilities our charges are moderate. *Try us.*

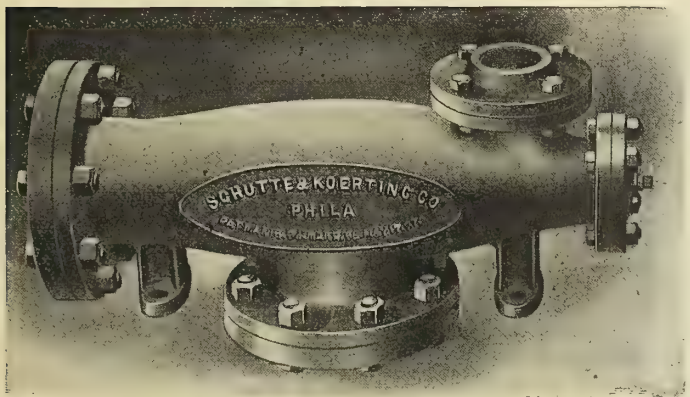


The Schaeffer & Budenberg Mfg. Co.

BROOKLYN, N. Y.

Chicago
Pittsburgh (35)
Washington

Körting Marine
Sewage Ejector



This Water-jet Eductor is used extensively

ON BOARD SHIPS

for discharging waste water from baths, lavatories, etc., which are situate near or below the water line.

It is absolutely reliable and requires no attention whatever. There are no moving parts to wear out and be replaced.

Further information, prices, etc., on application.

SCHUTTE & KÖRTING COMPANY

PHILADELPHIA, PA., U. S. A.

WE UNDERSTAND that several orders have been secured by Alex. Chaplin & Company, Ltd., of Govan, for cranes, and about twenty, steam and electric, and of varying type and power, are in hand for home and abroad. The firm recently supplied three overhead electric cranes of 60-ton capacity. These were built and installed within sixteen weeks in the new engineering shops of the London & Glasgow Shipbuilding & Engineering Company, Ltd., Govan. Two of them are of 47 feet and the third of 42 feet 6 inches span. They are three-motor cranes, the speeds for the several operations of lifting, cross-travel and long-travel being: Lift, 60 tons at 5 feet a minute, 25 tons at 11 feet 6 inches a minute, and lighter loads up to a speed of 15 feet a minute; cross-travel, 60 feet to 90 feet a minute; long-travel, 200 feet to 240 feet a minute. All the motors are wound for direct current at 500 volts.

UNDER THE HEADING of "Naval Shipbuilding Expenditure" the *Mechanical World* recently said: "It is doubtless correct to characterize expenditure on armaments as economic waste, but it is a waste which is recognized throughout the whole world. The money devoted to military and naval objects might be applied to better purposes in any country, but so long as any one nation continues to arm itself for offensive or defensive action, the other civilized nations seem compelled to follow the example for the sake of self-protection. Although the expenditure on naval armaments in the United Kingdom is enormous, it requires only a little consideration to show that the outlay confers great benefits upon a large number of workmen who are employed in the various departments which, combined, produce warships complete. The stoppage of a shipbuilding programme for a single year would throw many thousands of workers out of employment, and from this point of view the cessation of naval shipbuilding would be exceedingly disastrous to many thousands of other persons who would be directly affected by it. But there is no prospect either now or in the future of any such state of affairs being brought about in this or any other country. The First Lord of the Admiralty, who recently referred to the question of economic waste of expenditure on armaments, again expressed the hope that it may be possible to reduce the naval estimates for 1912-13. It is, however, quite clear that the First Lord is not so confident of the realization of this hope as he was six months ago, as he declared that our expenditure must depend upon the scale adopted in other countries. It therefore remains for the near future to decide what the shipbuilding programmes of other countries will prove to be for the next financial year; but we shall be much surprised if the international situation will permit of any reduction in the British expenditure in 1912-13."

ONE OF THE MOST POWERFUL LATHES ever constructed is in use at the Darlington Forge Company, Ltd. Its massive double-slide bed, 61 feet 6 inches long, 16 feet wide and 27 inches deep, is built up in two lengths jointed down the center, with five longitudinal and several transverse box girders, and is so arranged that an additional length can be easily added later. The lathe, which was built by Hulse & Co., Ltd., of Salford, will admit work 40 feet 6 inches long and 13 feet 4 inches diameter between centers. The fast headstock has two changes of double and two of quadruple machine-cut forged steel gearing, the changes being readily effected by means of racks and pinions. The spindle is 19 inches in diameter by 27 inches in length in the front bearing, and 15 inches diameter by 22½ inches in the back bearing. A large ball bearing is fitted to take the end thrust. The machine is driven direct through machine-cut double-helical forged steel gearing by a 100-brake-horsepower motor, having a speed variation of 3 to 1, mounted on the foundation plate at the front of the headstock. The keys on the shafts in the fast headstock are forged solid with the shaft, and all the sliding wheels are fitted with two keys. The face plate chuck is 12 feet in diameter, cast in one piece, bolted to a large collar forged on the spindle nose. The movable headstock has a forged steel spindle 12 inches in diameter. Four independent sliding carriages are provided, two at the front and two at the back, with transverse slide and extra holding-down strip. Each is fitted with a rotating nut and reversing gear, swing frame and machine-cut steel change wheels, these latter not only imparting the various rates of feed longitudinally for sliding or screw-cutting, but transversely for surfacing. Rotary motion is transmitted by means of longitudinal shafts driven from one of the quick-running shafts on the fast headstock through two changes of spur gearing, means of hand adjustment being also provided. The sliding carriages have a quick-transverse motion in both directions, driven direct from a 20-brake-horsepower constant-speed motor self-contained with the lathe. The range of spindle speeds is from 0.4 to 30 revolutions per minute.

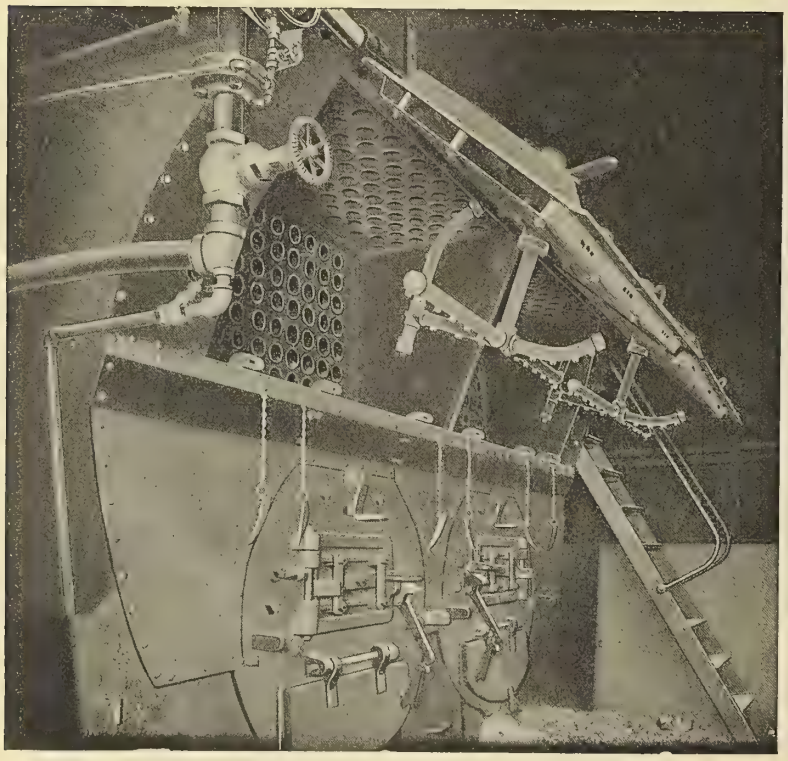
A NEW DESIGN of crane panel has been introduced by the Electric & Ordnance Accessories Company, Ltd., of Aston, Birmingham. Although these panels are of particularly substantial construction, both electrically and mechanically, they are considerably smaller and lighter than panels of the usual construction. The panels consist of a double-pole, quick-break main switch, with three or four double-pole branch fuses, enclosed in a cast iron case, which is provided with lugs for fixing. The main fuses are mounted on the movable switch arm, so that they can only be renewed when the switch is in the "off" position. Pilot lamps are mounted on the top of the case to indicate when the motors are entirely disconnected from the mains; connections for an inspection lamp are also provided. The panels are supplied to control one, three or four motor circuits, dealing with currents ranging from 50 to 400 amperes at pressures up to 600 volts.

AN APPARATUS which has been brought to Great Britain by Mr. Victor Nightingall, an Australian inventor, is designed to enable communication to be established by night between ship and shore or ship and ship by means of light signals according to the Morse code, even though those working it are not adepts in that code. For this purpose the ship is provided with a number of metal plates, each representing a letter of the alphabet, which can be fixed to a wheel forming part of the apparatus, and which, when the wheel is rotated, by means of suitable projections close the circuit through an electric lamp, and thus cause it to flash out the dots and dashes corresponding to the letters. To use the apparatus the sailor consults the international signal book, picks out the letters which stand for the message he wishes to send, fixes the corresponding plates on the wheel, and pulls a lever which both sets the wheel in rotation and switches on the current to the lamp, either from the ship's dynamo or from a battery. The apparatus then continues to send the desired message automatically without further attention until it is stopped. As the signals are shown comparatively slowly, and are repeated at each revolution of the wheel—or oftener if duplicate sets of plates have been fastened to the circumference—any one on another ship ought to be able to decipher them by reference to a Morse alphabet; and then, having made out the letters, whatever his nationality, he has only to consult his international signal book to discover the meaning of the message.

JNO. HY. ANDREW & COMPANY, LTD., of Toledo Steel Works, Sheffield, recently appointed Bernard Holland & Company, of 17 Victoria street, S. W., to act for them in London and district so far as the British government departments, railway companies, engineers, shipbuilders, contractors, etc., are concerned.

OIL ENGINES which have been recently constructed by William Beardmore & Company, of Glasgow, include a 45-horsepower crude-oil engine for a steel fishing vessel which has just been constructed at Amsterdam; a 38-horsepower auxiliary paraffin engine for a schooner trading in Australian waters, and a crude-oil engine of 45 horsepower for the Crown Agents for the Colonies. In addition they have built for the Irish Congested Districts Board two motors—a 60-horsepower crude-oil engine and a 38-horsepower paraffin engine. They have also supplied a 120-horsepower crude-oil engine for a new yacht to the order of the Marquess of Graham.

THE BRITISH OXYGEN COMPANY, LTD., state that they have decided to erect an oxygen factory in Sheffield, where they consider the growing demand for oxygen in connection with metal cutting warrants this extension. When the Sheffield plant is completed the company, which in 1908 had only three factories (London, Birmingham and Manchester), will possess eight factories in the United Kingdom, all situated in centers where the demand for oxygen is important—at London (Westminster and Greenwich), Birmingham, Cardiff, Manchester, Sheffield, Newcastle and Glasgow. These extensions are entirely due to the demand for cheap oxygen in connection with oxy-acetylene welding and oxygen metal cutting. In view of the heavy freight charges on gas cylinders conveyed by rail, it is obvious that local sources of supply must tend to reduce the price of oxygen to the consumer. All the company's plants are of the modern liquid air type, producing oxygen of a high degree of purity, and when the Sheffield plant is in operation their total output will be about 300,000 cubic feet a day. This supply is largely in excess of the present demand, but it is anticipated that this quantity may ultimately be required if the use of oxygen for metal cutting extends. The present average price of oxygen, supplied in cylinders, for industrial purposes is about £2 per 1,000 cubic feet, but reductions are expected if the demand increases.



"Diamond" Front End Marine Soot Blower

With Smoke Box Doors Open and Showing How the Entire Mechanism is Withdrawn from Smoke Chamber.

It Costs Money to Force Heat Through Soot

A one-tenth inch coating of soot on your boiler flues resists heat to a greater degree than a full inch of asbestos. You would not think of running your boiler with the tubes wrapped in asbestos. And yet a slight coating of soot causes the loss of more heat—and the waste of more fuel—than does asbestos.

This "Diamond" Soot Blower

Keeps the Tubes Free of Soot—Cuts Down Your Fuel Bills—Doubles the Efficiency of Your Boiler

Send for copy of New Circular Just Issued

"Diamond" Power Specialty Co.

58 First Street, Detroit, Mich.

THE DIAMOND BLOWER COMPANY
75 b Queen Victoria St., London, E.C., England

MARINE SOCIETIES.

AMERICA

AMERICAN SOCIETY OF NAVAL ENGINEERS.
Navy Department, Washington, D. C.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
29 West 39th Street, New York.

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An international exhibition of non-ferrous metals is in course of arrangement by Mr. Fred. W. Bridges (organizing manager), under the presidency of Sir Gerard A. Muntz (president, Institute of Metals). The Royal Agriculture Hall, Islington, has been booked from May 6 to 18, 1912. Judging from the experience which the organizing manager has gained in previous exhibitions he has been connected with, and the results achieved, the success of the exhibition now being organized is assured.

The works and business of the Société Escaut et Meuse at Val Benoit, near Liege, have been transferred to a new company formed with the co-operation of the Société Cockerill and the Société d'Ougrée-Marihaye, under the name of Société des Usines à Tubes de la Meuse. This company, with a capital of 5,500,000 francs, will engage in the manufacture of iron and steel tubes and accessories of various kinds.

For several years now, says the London correspondent of the *Manchester Guardian*, Norwegian companies have monopolized the whaling industry in the Southern Ocean largely by means of second-hand British steamers adapted for the purpose. Their efforts off the southeast African coast and in the vicinity of the South Shetlands have, I hear, been so successful that one or two British firms are about to embark in the business. A fleet of five vessels will leave the Tyne for Kergulen Island towards the end of next month, and all of them will be equipped with wireless telegraphy, while three will have Diesel engines as their motive power. One of these is the old Clyde-built barquentine *Sound of Jura*, which has been fitted with tanks for storing the oil. I hear also that a Liverpool firm is having three vessels built for the sealing industry off the Newfoundland coast, and they are to be supplied with internal-combustion engines.

A Barrow correspondent of the *Newcastle Daily Chronicle* states: "There are very bright prospects for the shipbuilding and engineering trades at Barrow, as it has been agreed upon that one of the two Turkish dreadnoughts shall be built by Vickers, Ltd., and the Admiralty Commission of Chili has recommended that the two Chilian dreadnoughts shall be built in this country by Armstrong's and Vickers, who in both the Turkish and Chilian negotiations have been working in combination. The Turkish warships are to be of 23,000 tons displacement, and the Chilian of 28,000 tons displacement. No British battleship has yet reached these dimensions. The guns with which these vessels will be mounted are of 14-inch and 15-inch calibre, respectively. Similar guns will be placed on modern warships now in course of construction. There is building at Barrow a Japanese battleship cruiser, which will be a better equipped vessel than even our battleship cruisers. There is also in course of building at Barrow a Chinese cruiser and other craft of up-to-date characteristics. The prospects are that shipbuilding and engineering at the Barrow yard of Vickers, Ltd., will be very busy for some years."

The trials of the Diesel engine of 1,000 horsepower for a vessel of the Woermann Line were completed recently at the Nürnberg works of the Maschinenfabrik Augsburg-Nürnberg. It is of the two-cycle double-acting type, running at 125 revolutions per minute normally. There are three working cylinders and three separate scavenger pumps in line with the working cylinders, and driven direct by an extension of the crankshaft. Air pumps for maneuvering and starting are driven by a separate motor. The floor space occupied by the scavenger pumps is very nearly equal to that taken by the working cylinders, and at first the engine appears to be somewhat larger than would have been expected; the over-all space occupied by the bedplate is about 25 feet by 9 feet, and the height from the bottom of the bedplate to the top of the working cylinders is about 14 feet or 15 feet. The arrangement for reversing, although complicated by the fact that the engine is double-acting, is comparatively simple. The cam shaft itself is turned through an angle of about 30 degrees, by which motion all the cams are set in their proper positions for running in the reverse direction. So easy is the manipulation that the engine is changed over from full speed ahead to full speed astern in less than ten seconds, which is rapid enough for all requirements. The scavenging air before passing into the working cylinders is cooled by being taken through a copper cylindrical vessel. The pistons and rods are oil cooled, the oil being itself cooled by circulating through a special cooler. The cylinders are cooled in the usual way by water. The Nürnberg firm have lately built a very large shop for the construction of Diesel marine engines, which is already well filled. Several 850-horsepower high-speed Diesel marine engines, running at about 400 revolutions per minute, are under construction or are completed for use in submarines. These have eight working cylinders and two air pumps on the same shaft in line. The scavenger cylinders are arranged directly underneath the working cylinders, and they have a stepped piston, the piston of the scavenger pump forming in reality the crosshead of the engine. These submarine engines are all of the two-cycle single-acting type, and are of very light construction. The frame and bedplate are built of manganese bronze. Engines are on order for the Dutch, German, Italian and the Austrian navies.

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